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ILLUSTRATED

SCIENTIFIC NEWS

Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

"*Let Knowledge grow from more to more*"
—TENNYSON.

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Knowledge & Scientific News

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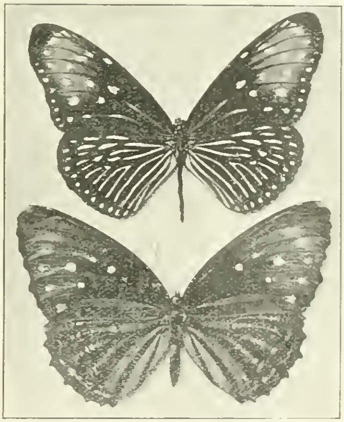
Dimorphic Mimicry among Butterflies.

PERHAPS the most striking instances of true mimicry are those which may be described as dimorphic. Not infrequently, but for reasons which are generally very obscure, the sexes of a butterfly differ so widely in colours and markings that the casual observer would certainly take them for representatives of distinct

Euplœa linnei ♂. *Elymnias leucocyma* ♂. Ex Assam.

species. And when such a difference exists between the male and female of a well-protected butterfly which is a prototype for mimicry the male and female of the mimicking species are sometimes seen to have each followed out, almost line for line, the colour characteristics distinguishing the sexes of the distasteful insect. This is well shown in the case of *Euplœa linnei* and *Elymnias leucocyma* from Assam. The males of both these species have shining blue fore-wings, spotted with white; the fore-wings of the females have a circumscribed blue area, spotted with white, while

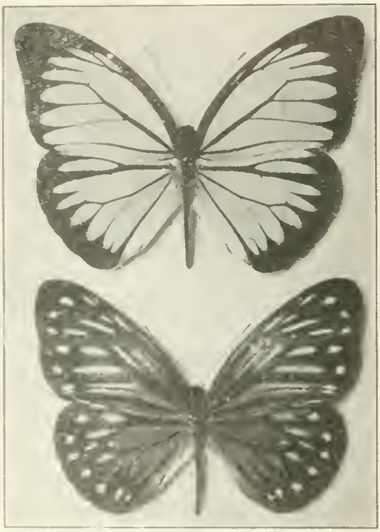


Euplœa linnei ♀. *Elymnias leucocyma* ♀. Ex Assam.

Bahora aspasia ♂ and ♀. Ex Sumatra.

their hind wings are brown with pale stripes. Yet the species belong to entirely different groups, and are related by no closer bond than that of mimicry. The *Euplœa* is the evil-tasting prototype. The *Elymnias* belongs to a group of poorly-protected butterflies allied to the *Satyridæ*, or "Browns."

Again, instances occur in which the female of a species is mimetic, while the male is either non-mimetic or else resembles a prototype quite distinct from that followed by its mate. In the case of *Eronia valleria* (from Sumatra, Borneo, etc.), the male may, perhaps, be regarded as an imperfect mimic of the striped species, a *Danais*, so common in these islands. The female is a very close mimic of *Bahora aspasia*, from



Eronia valleria ♂ and ♀. Ex Sumatra. (Compare female with that of *B. aspasia*.)

the female of which the inexperienced observer would be unable to separate it.

Sometimes a single species has two or more distinct forms of the female, each of which is coloured in mimicry of a separate evil-tasting species. In illustration of this, the case of *Papilio pammon*, a species having a wide range in the East, may be cited. The male of this butterfly is black, the fore-wings having a marginal row of white spots; the hind wings having a curved, transverse band of white, divided into spots by the nervures. There is a form of female almost exactly like the male, but it is somewhat rare. The common forms of female are entirely dissimilar to their mates, and were described as different species by the old naturalists. That which was called *P. polytes* has a large white spot, broken by nervures, in the middle of each hind wing, and a row of large red marginal spots. The dark brown fore-wings are striped with a pale colour. The other common form of *P. pammon* female, described originally as *P. romulus*, has extensive red markings on the hind wings, and no white spot. Its fore-wings are crossed with two broken bands of white.

Papilio pammon ♂ and ♀ (form like ♂).

These two forms of female mimic respectively two distinct species of butterfly, belonging to another

Papilio aristolochiæ. *Papilio pammon* ♀ (*polytes* form).

section of the great *Papilio* genus, which appear to be well-protected insects. The *polytes* variety of *P. pammon*

is curiously like *P. aristolache;* the *romulus* form is an equally close mimic of *P. hector*.

These wide differences existing between the sexes of a mimicking species seem at first very difficult to understand. It has been suggested that the males, for some reason, are better able to protect themselves than are the females, and do not, therefore, need the protection of a mimetic likeness to a warningly coloured type. In some cases the males certainly seem stronger on the wing, and better able to escape from danger by flight; while it is obvious that the females, when depositing their eggs upon vegetation, would run more risk of being attacked by birds and other insectivorous creatures than their mates, who are free from preoccupations likely to detract from their alertness.

The question as to how such wide differences between the sexes of one species came to be seems, at first, a very perplexing one, especially in cases where two or more mimicking varieties of the female exist. We know that living creatures often exhibit a strong tendency to vary, but these several well-marked forms of one species seem to be something more than the outcome of mere "sports."

It is possible—at least, in some degree—to show how they have been produced and established. There are two common butterflies of the family *Nymphalidæ*, known respectively as *Hypolimnas misippus* and *H. bolina*. These species have their headquarters in India, but they have a wide range in the Eastern Hemisphere. They are closely related, and the males are very similar—both having blackish wings, with

Papilio hector. Papilio pammon ♀ (*romulus* form).

central areas of white beautifully tinted with shining purple. The females of both species are curiously variable, and are well worth a careful study by those seeking to comprehend the theory of mimicry. Taking first *H. misippus*, we find that no female at all like the male in appearance is known to exist. The common form of female is that shown in the accompanying photograph. It is bright tawny, bordered with black, and has a conspicuous band of white in the fore-wing. In this it is seen to be a wonderfully accurate copy of

Danais chrysippus. Hypolimnas misippus ♀. *Hypolimnas misippus* ♂.

that common and much-mimicked Eastern butterfly, *Danais chrysippus*. This insect (*D. chrysippus*) is common all over Africa and Southern Asia, and there are a number of closely allied forms—whether constant local varieties or actual species is not definitely known. These forms vary a good deal in colour and marking. For instance, in *D. alcippus* the hind wings are almost entirely white; in *D. klugi*, all the wings are tawny, with black edges, and there are no white bands in the fore-wings. The range of *H. misippus* is very similar to that of *D. chrysippus* and its several forms, and wherever a marked difference is seen in the appearance of the latter, it is found to be reproduced upon the wings of the mimicking females of the former, usually in a strikingly close manner. But though the females vary in different districts, the colouring of the males is identical in each locality.

These facts—the extraordinary difference between the sexes, the various forms of the female, none of which are in the least like the males—are very surprising; but in the case of the allied *H. bolina* we find, in measure, a key to the mystery. The females of this butterfly vary in a much more erratic manner than do those of *H. misippus*, albeit none of them has attained to such striking mimicry. There is a form (shown in the accompanying photograph) which is an imperfect mimic of the common evil-tasting butterfly, *Euplœa core;* there are also dozens of other forms, all exhibiting some marked difference, but few showing any tendency towards a mimetic likeness. The group of

females showing the gradual growth of the tawny colour, however, is interesting. The colour (which is quite unknown on the wings of the male) makes its

Eupl[illegible] c re. Hyp[illegible]mnas bolina . . *Hypolimnas bolina* ♀.

appearance as a small spot, and may be traced from one specimen to another until it is seen to form a large suffusion in the wing-area. Such specimens go far to

H[illegible] [illegible]s. Upper one like male.

bridge over the gap between the *H. misippus* male and its perfectly mimetic, tawny females; for these tawny blotched females of *H. bolina* seem to show a definite variation in the direction of the *Danais chrysippus* prototype. It is conceivable that eventually, through the agency of natural selection, this dawning mimetic likeness may be perfected and established, as it appears to have been in the case of *H. misippus.*

It is impossible to suggest a reason to account for the different courses of natural selection in the case of species so closely related. The fact remains, however, that whereas the colour specialisation of *H. misippus* appears to be fairly complete, that of *H. bolina* is still in an elementary stage. The females of *H. misippus* differ both from the male form and from one another, but always in the direction of some well-protected prototype; moreover, there are no intermediate forms. The females of *H. bolina*, on the other hand, vary from specimens that are almost like the males through an extensive range of closely connected forms, very few of which approach any existing warningly-coloured prototype.

Although the mimicking *Hypolimnas* butterflies are often instanced as cases of true or Batesian mimicry, some authors consider them to be typical of what is known as Müllerian mimicry, in which both the type

Hypolimnas bolina ♀ s.

and the copy are well-protected insects, deriving enhanced benefit from their mutual likeness. The theory of convergent mimicry, as suggested by Professor Müller, will be described in a subsequent article. But the question as to which section of mimicry the *Hypolimnas* butterflies rightly belong in no way affects the interest attached to their colour development as described above.

An instance of the manner in which butterflies belonging to widely distinct families develop a close external likeness one to the other, because of their mimicry of a common distasteful type, is seen in the annexed photographs. The prototype is *Amauris dominicanus* from South Africa. This is mimicked by one form of *Papilio cenea* female, which, it is seen, differs from the male not only in colour and marking, but also in the complete loss of the long "tails" of the hind wings. Then the Nymphaline butterfly, *Euralia* (*Hypolimnas*) *anthedon*, in both sexes, is a very perfect mimic of the *Amauris.*

There is also, in Cape Colony, another form of *Papilio cenea* female, which is a striking mimic of

another butterfly of the evil-tasting group (*Amauris echeria*), which is black blotches and spotted with rather dusky yellow. This form is very like another species

Papilio cenea ♂. Ex S. Africa.

of *Euralia*, which also mimics the *A. echeria*. Finally, there is a third form of *P. cenea* female, tawny in colour, marked in black and white in imitation of *Danais chrysippus*; and, as we have seen, the females of *Hypolimnas misippus* are very perfect mimics of the same species.

Amauris dominicanus. *Papilio cenea* ♀. Ex S. Africa

In regard to the multi-form females of *Papilio cenea*, it should be pointed out that there exist in Madagascar and Abyssinia closely allied species, the females of which differ very little from the males. Not only have they the same pale yellow and black colouring, but the hind wings preserve the characteristic tails. There is, however, a prominent black bar on the costal margin of the female fore-wing; and it is presumed that this represents the commencement of the darkening, which, in the case of the allied mimetic females, has suffused so large a portion of the wing area.

The question as to why the females of species closely related to others which are very perfect mimics should have retained their ancestral form is difficult to answer

Euralia anthedon ♂ and ♀. Ex S. Africa.

satisfactorily. In the absence of contradictory evidence, however, it is quite admissible to assume that the life histories of these non-mimetic species have been fraught with less hardship and persecution than fell to the lot of those which have gained the protection of mimicry. In the case of *Papilio meriones*, this view is certainly plausible, and is adopted by Professor Poulton. "It requires a very slight exercise of the imagination," he says, "to picture the steps by which these marvellous changes have been produced; for here the new forms have arisen at so recent a date that many of the intermediate stages can still be seen, while the parent form has been preserved unchanged in a friendly land, where the keen struggle of continental areas is unknown."

The Fourth International Ornithological Congress.

The Fourth International Congress of Ornithologists will be held, as arranged at the previous meeting at Paris in 1900, in London this year, under the presidency of Dr. R. Bowdler Sharpe, the head of the Ornithological Department of the British Museum. It will assemble at the Imperial Institute, South Kensington, on Monday, June 12, and sit until the end of the week, during which, besides the ordinary business, it is proposed that evening meetings and short excursions shall take place. Longer excursions will be made after the close of the meeting. An Organizing Committee has been formed to make the necessary arrangements.

The Secretaries to the Congress will be Dr. Ernest Hartert, of the Zoological Museum, Tring, and Mr. J. L. Bonhote, of Ditton Hall, Cambridgeshire, to whom communications may be addressed. The Treasurer will be Mr. C. E. Fagan, of the Natural History Museum, South Kensington. It is hoped and expected that many of the leading ornithologists from all parts of the world will attend the Congress.

Our Sun and "Weather."

By WILLIAM J. S. LOCKYER, M.A., Ph.D.

"The moon and the weather
May change together;
But change of the moon
Does not change the weather.
If we'd no moon at all,
And that may seem strange,
We still should have weather
That's subject to change."—*Notes and Queries.*

THERE are many of us who would like to know whether our next summer will be sunny and warm or our next winter dry and cold, so that we might prepare for the delights that could be enjoyed by such weather conditions. That day is not however with us yet, and its delay in coming is owing to many reasons, the chief among which being that civilized nations were not so widely scattered over the earth as they are now, and that consequently meteorological records extending over a long period of time do not exist in sufficient number to allow of a complete discussion being made.

If we only had behind us one hundred years of good meteorological observations made in the way that they are to-day, and also an unbroken record of observations of sun-spots and prominences, then we should be in a far better position to tackle such meteorological problems as are now lying before us unsolved.

Unfortunately one cannot go much further back than about fifty years when discussing the great majority of meteorological observations, for in many cases they are either very sparse and broken, or it is not known with what degree of accuracy they were made. In the case of solar phenomena the investigator is still more restricted; for, although the observations of sun-spots have been made in a more or less crude manner for a great number of years, it was not till about the year 1830 that a systematic method of observation was adopted; further, the solar prominences, important indicators of the sun's activity, were only first recorded systematically in the year 1872. The reader will therefore understand that before all these different phenomena can be correlated to enable long-period forecasts to be successfully made, a greater period of time than the one at present available is absolutely necessary.

This is, however, no reason why attempts should not now be made to find out whether these solar and terrestrial changes are related to each other, and if possible to point out how, from our present material, such a relationship, if detected, can assist us in making at any rate rough forecasts of approaching seasons.

It is generally acknowledged that we are children of the sun, and life on this earth is only possible in consequence of his presence. Our sun is, so to speak, the fuel on which we are all dependent, and it is, therefore, quite natural to look to him as the instigator of our "weather." Now, our orange-shaped globe is surrounded by the atmosphere. The sun from without pours his rays down on the earth's surface and heats it, whether it be water or land; this heated land or water warms the atmosphere in contact with it, and this warmed air, which is now lighter than it was before, rises from the surface and is replaced by the cooler and heavier air flowing in at the bottom. In this way a current of air, a wind, is set up. The land or water most heated in this manner is that which lies in those regions over which the sun during a year passes overhead, and the reader will at once gather that this part of the world is that which includes the equatorial regions. It is due to the heating of this region, coupled with the great cooling about the terrestrial poles in consequence of the presence of ice and snow, that the whole mechanism of the circulation of the atmosphere is set in motion and maintained, and "weather" is the ultimate result of this circulation. Fortunately for us—but unfortunately for meteorologists—the surface of the earth is not completely covered over with water, but is studded here and there with great stretches of land, so that an unequal heating of the atmosphere round the equator takes place, and the directions of the atmospheric currents the further the equator is left behind, combined with the rotation of the earth, become more complicated than they otherwise would be.

To study the action of the sun on the earth to its fullest extent it is therefore best to begin in the region about the earth's equator where the solar action is greatest; and when this is completed, to trace this action, which would probably be communicated by the air currents, to the regions in higher latitudes.

Fig. 1.—The Sun, as photographed with an ordinary telescope, showing the spots on his disc, taken about the time of sunspot maximum.

It is well known not only in these but in all other latitudes that the "weather" is not the same every year. Sometimes there is a great abundance of rain, sometimes very little; one winter is very mild while another is very cold. In fact each continent has its own little meteorological worries such as floods, droughts, famines, &c. Thus India has just recovered from the most severe famine ever known, while Australia is labouring from a similar visitation. There seems little doubt that all these conditions are produced by changes in intensity or direction, or both, of the main currents in our atmosphere, and since these conditions depend for the main part on the distribution of atmospheric pressure, it is this element which should receive the closest attention.

It has been stated above that the most likely cause of these variations finds its origin in the sun, for, granting a change in his heating powers, the strength of the atmospheric currents, and consequently the atmospheric pressure, would be accordingly altered.

The question therefore arises, Does the heating power of the sun vary? This is difficult to answer directly, although from certain observations of his surface, to which

reference will now be made, the deduction is that great heat variations do occur.

If the sun's disc be scanned from time to time, it will be found that sometimes there are spots and sometimes there are none (fig. 1). According to our present knowledge these spots are produced by the descent of comparatively cool matter from the higher reaches of the solar atmosphere, so that the more spots there are, the greater the quantity of matter descending. Since this falling material is the result of previous uprushes of highly heated matter from the lower levels of the sun's atmosphere, it stands to reason that this spot phenomenon indicates great solar atmospheric disturbance and therefore greater activity and consequently more intense heating capacity. Thus we arrive at the conclusion that the greater the number of spots, the greater the solar activity and therefore the hotter the sun.

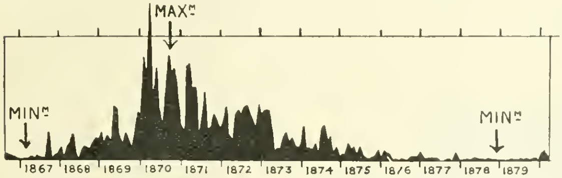


Fig. 2.—The dark portion shows the variation in the amount of the total spot area on the Sun from year to year for an eleven-year period. Notice the three prominent outbursts in the years 1870 and 1871.

Now there is a decided periodicity in spot activity. For some years only a few spots become visible, while a little later they become more numerous until a maximum is reached, after which they begin to dwindle again in numbers until the succeeding minimum is attained when the sun remains spotless for months together. The accompanying diagram (fig. 2) will give the reader a good idea of this variation. The dark portion, which looks like a silhouette of a cathedral city, shows the change of the amount of "spottedness" of the sun for each solar rotation from the year 1867 to 1879; the arrows indicate the "epochs" or times, as determined from a curve specially smoothed for this purpose, when there are fewest (minimum) or most (maximum) spots. It will be noticed that there is not a gradual increase of spotted area, but that, as the diagram shows, there seem to be intermittent outbursts. From this figure, which includes a whole sunspot cycle, it will be seen that the time from one minimum to the next is about twelve years; this, however, is not always the case. A glance at the next diagram (fig. 3) shows that since 1834 the lengths of these periods are alternately longer and shorter than the preceding one, the mean length being a little more than eleven years. It will thus be seen that the so-called "eleven year cycle" of sunspots is only *approximately* true. A reference again to figure 2 shows further that the epoch of maximum occurs nearer the preceding than the following minimum; this is always the case, only from one period to another this interval from minimum to maximum is not the same. To illustrate this, these intervals are arranged in figure 4 one below the other, and instead of an alternate change in length they recur every third period. Thus if this apparent law holds good the approaching maximum will occur about a little more than three years after the last minimum (this occurred in about the middle of 1901), that is about the end of the present year (1904). Another curious fact relating to the sun-spot cycle is that when the interval from minimum to maximum is shortest, the total amount of "spottedness" included in the whole period from minimum to minimum is greatest. This is graphically shown in the accompanying diagram (fig. 5). The last square represents the relative spotted area that may be expected for the present cycle if the previous conditions be repeated.

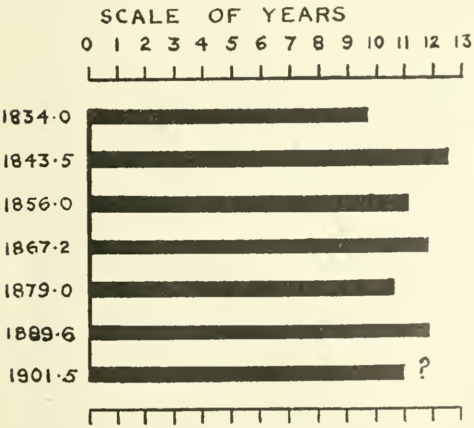


Fig. 3.—The lengths of the period from minimum to minimum change alternately.

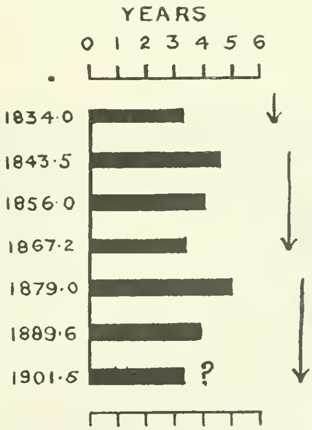


Fig. 4.—Diagram to show that the interval between a minimum and the following maximum changes in a cycle of about 35 years.

The above brief summary of the sun-spot variations tells us that not only does the heat of the sun change, but that these changes occur in cycles of about eleven and thirty-five years. There is, further, another cycle, not very well indicated, which has a period of less than eleven years, probably the same as that which is more clearly defined by the solar prominence observations to which reference will now be made.

The solar activity can also be gauged from "prominence" records. These disturbances are probably of more consequence than those of spots. The latter are strictly limited as regards position on the sun's surface

to a comparatively narrow zone near each side of the solar equator, while there seems no such restriction to the former. Again, if the relation between the areas of spots and prominences be considered, those of the former are practically insignificant. A study of prominences is therefore of the highest importance when the activity of the solar atmosphere is in question, but, unfortunately, records of these only commence in the year 1870. Unlike spots, which, as previously pointed out, are the result of the descent of comparatively cool matter from the upper regions of the solar atmosphere, prominences consist of ascending currents of highly-heated matter from the lower

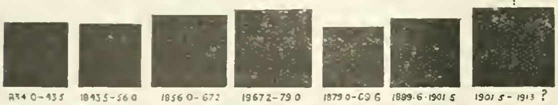


Fig. 5.—If the areas of all the sunspots which appear on the Sun's disc from one minimum to the next be added together, then the above squares show the relative change of spotted area for each of the periods from the year 1834.

to the higher layers; indeed, they are the precursors of spots and are thus more direct indications of solar disturbances. That they are very important factors in solar "weather" can be gathered from their enormous magnitudes, some of them being 100,000 miles or more in height and correspondingly broad.

Prominences, like spots, have periods of maximum and minimum frequency. As a rule, when there are few spots there are few prominences, and when the spotted area is large so is that of the prominences. There is thus a very close connection between these two

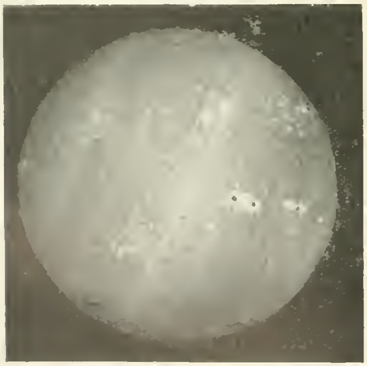


Fig. 6.—A picture of the Sun taken in light of one colour, showing that there are other areas on the solar disc which are more extensive than those of spots. The former appear bright while the latter are dark.

phenomena; but it must be stated that this connection only holds good when the prominences situated nearest the equatorial regions of the sun are alone taken into consideration. It is due, however, to the fact that prominences are at times very numerous near the solar poles that the curve representing the mean variation of their frequency from year to year does not rise or fall gradually throughout a cycle, but is of a wavy nature, as can be seen by a glance at the curve shown in a subsequent figure (fig. 7). It is this peculiarity that makes the prominence curve so important, for these "humps" on the main curve represent solar changes of activity that are scarcely traceable on the spot curve. There seems reason to believe, therefore, that the observations of prominences are capable of giving us far more information regarding the circulation and activity of the solar atmosphere than those of spots.

We thus see then that the study of spots and prominences has made us acquainted with three different periods of solar changes. Thus we have a short period of a little less than four years, another cycle covering in the mean a little more than eleven years, while a third variation occupies about thirty-five years.

Having thus briefly summarised the chief facts concerning the various changes of solar activity, attention will now be paid to the records of meteorological phenomena to see if any trace can be found corresponding to these solar variations. The question now arises as to which meteorological element should be chosen to commence operations with. For several reasons, which need not be mentioned here, barometric observations have been selected, for they supply us with an excellent means of detecting variations of pressure which are direct indicators of air movements towards or away from the earth's surface. Greater solar radiation means greater heating power, and therefore stronger ascending currents away from the earth in some parts of the world, and consequently greater descending currents in other parts; thus we should expect to find lower and higher pressures simultaneously in different regions of the earth's surface.

A decided great advantage in employing barometric records is that the variations of this element from year to year are very similar over large areas, and do not change according to local conditions as is the case with rainfall. Thus, to take the case of the British Isles, for example, the pressure variation of, say, Oxford is quite sufficient to illustrate the variation over the whole of the British Isles, as if we employed the records of Valencia, Aberdeen, Greenwich, or Edinburgh, which are all quite similar. Rainfall is the *effect* and not the cause of barometric pressure variations, and we in these islands are quite familiar with this fact. A fall in the barometer with us generally means rain, and a rise probably dry weather. Rainfall then being an after-effect of pressure, any variation of the latter should have a very close connection with the former.

(*To be continued.*)

Messrs. Adolph's Selenium Cells.

We have received from Messrs. Adolph, of Farringdon Road, a catalogue of their selenium cells; and selenium cell apparatus. The great interest of selenium to the electrician lies, as everybody knows, in the alteration which becomes apparent in the electro-conductivity of this element as the light thrown on it varies. The relation between the change of electric resistance and the amount of illumination has been expressed mathematically; and if selenium could always be depended on to behave with perfect regularity, some of the practical uses to which it could be put might effect astounding revolutions in light telephony. Herr Ruhmer, in Berlin, has endeavoured to transmit sounds along beams of light by the employment of selenium cells, and within certain limits the experiments have been successful. What is wanted most, however, with regard to selenium, is new and continued experiment; and the opportunity which Messrs. Adolph afford of bringing within the reach of laboratory students selenium cells of all kinds, as well as apparatus for testing its properties in light telephony, and its applications to other branches of research, is one that we warmly welcome.

Electrotyping.

By Dr. F. Mollwo Perkin.

No one has been long in a chemical laboratory without having learnt that one of the simplest tests to ascertain whether a solution contains copper is to place the blade of a pen-knife into it. If copper is present the blade of the knife becomes covered with a thin coating of copper. Other metals besides copper can be plated out upon another metal by simply immersing it in their solutions. For example, if a silver article is dipped into a solution containing a gold salt, it will become covered with a thin coating of gold. This process of dipping is to a certain extent actually performed in practice, hence one is accustomed to talk of giving an article a gold wash. For example, at one time the method employed for gilding the inside of silver boxes, the bowls of spoons, &c., was to wash them over with a piece of rag which had been dipped in the gold solution. When a metal is plated by simply immersing it in the solution of the other metal, then an equivalent of the metal which is being plated upon it goes into solution. Thus, when the blade of a knife is placed into a solution of a copper salt and becomes superficially coated with copper, it is only done at the expense of a portion of the blade which goes into solution. Supposing the solution to consist of copper sulphate, then as copper is deposited out, sulphate of iron takes its place. Thus we can write it in the form of an equation :

Copper sulphate + iron = iron sulphate + copper or by using symbols

$$CuSO_4 + Fe = FeSO_4 + Cu.$$

The metal which goes into solution and upon which the other metal becomes plated out is said to be electropositive to the metal in solution. Zinc is the most electropositive of all metals, and under appropriate conditions is able to replace all other metals from the solutions of their salts.

Now this method of plating or depositing out a metal has only a very limited application. It is used to a certain extent in gold plating, but not for depositing such a metal as copper. The methods employed are electrolytic. It is found if an electric current is passed through a solution of a metallic salt, *e.g.*, copper sulphate, that the copper is deposited out upon the one electrode,* and at the other electrode if it is of an insoluble material, such as platinum or graphite, oxygen gas is evolved. The pole at which the metal is deposited is called the negative pole or cathode, the one at which oxygen gas is evolved, the positive pole or anode. Fig. 1 shows such a cell diagramatically. A is the negative electrode or cathode (—) and B is the positive electrode or anode (+).

If instead of being made of an insoluble material the anode B consists of a sheet of copper, then as the electric current passes the copper will go into solution. Furthermore, the copper will pass into solution at the same rate as the metal is plated out upon the cathode A; theoretically, therefore, the strength of the solution will remain constant. As a matter of fact, owing to secondary changes, after a time it becomes too concentrated.

* When two pieces of metal connected with the opposite poles of an electric battery are immersed in a solution, as shown in the figure, these pieces of metal are called electrodes.

Electroplating was first suggested by Elkington in 1836, but he did not apparently employ it on an industrial scale. It is very interesting to note that some of the articles obtained from the coffins of the Egyptian mummies have been found to be coated with copper; probably, however, the coatings of copper in these cases were produced by simple immersion. On an industrial scale electroplating was first introduced by M. H. Jacobi, of St. Petersburg, in 1838. Since then, especially of late years, an enormous industry has been developed. By simple immersion heavy deposits of metal cannot be obtained, but coats of any thickness can be produced by electro-galvanising. In this article it is intended to deal not with plating in general, but with the application of the electric current for producing electrotypes or reproductions; this form of electrodeposition is sometimes called galvanoplastic.

In all cases of reproduction the article to be reproduced is made the cathode in a bath of copper sulphate, and a strip of copper the anode. Now, supposing it is desired to reproduce a medallion, if this be of metal and is made the cathode, copper will be deposited upon it, but the copper will adhere so firmly that it will be impossible to remove it. It is, therefore, necessary to

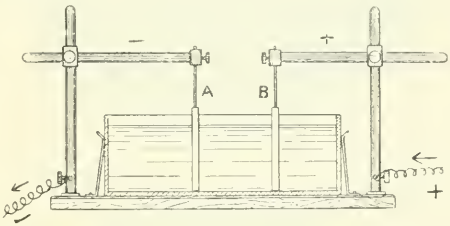


Fig. 1.

coat the medallion with an extremely thin film of some material which will prevent the deposited metal from adhering to the metallic surface. This coating must not be sufficiently thick to obliterate or blur the details of the figures, &c., upon the article which it is desired to reproduce. There are several methods which may be employed. If the medallion is of silver or copper, its surface after being carefully cleaned so as to remove dirt or grease, is washed with a solution of sodium sulphide, by which means the surface of the metal is coated with an extremely thin film of sulphide of the metal. This surface is conducting, but prevents the deposited metal from adhering to the article. Another method is to cover it with a thin coating of black lead (plumbago). The coating must be very thin and should be polished in much the same way as the iron-work of a fire-place is polished. In practice, machines are generally used for polishing and plumbagoing surfaces, as it is not an easy matter to get a perfectly smooth and even surface by hand.

Having satisfactorily prepared the surface of the article, it is hung by means of a copper wire in the depositing bath and connected with the negative pole of the source of current. The conducting wire where it dips below the surface of the copper solution should be covered with an insulating material, such, *e.g.*, as a piece of rubber tubing. As soon as the circuit is closed and the current passes, the surface of the article becomes coated with a thin film of copper, which gradually increases in thickness, until a coating of about $\frac{1}{4}$ to $\frac{1}{2}$ a millimetre in thickness has been obtained. It

should be mentioned that the back of the article is coated with some non-conducting material, such as solid paraffin wax, otherwise the whole article would become covered with copper, and it would then be impossible to remove the deposited metal. In depositing the metal certain precautions have to be taken. Thus, for example, the regulation of the current strength (current density) is a matter of great importance. If a heavy current is employed, the copper is very apt to

A

B

Fig. 2.

be deposited in a rough and irregular form, and may be so powdery as to actually rub off. The colour of the copper is bright, and the appearance smooth and regular when low currents are employed, but it is rough and brown (burnt) with currents of too great intensity.

When a sufficiently thick deposit has been obtained the article is removed from the bath, well washed with water, and dried. The point of a pen-knife or other sharp instrument is then inserted under the edge of the deposited metal and the metallic coating carefully stripped from the article upon which it has been deposited. Sometimes it is rather difficult to strip it without bending and injuring the thin metallic shell, and when this takes place it is not by any means an easy matter to properly smooth it out again. The thin shell thus obtained is backed up with lead or with an alloy of lead, which melts at a lower temperature than the lead itself. In order that the backing metal may adhere satisfactorily, the back of the shell must first be tinned; a satisfactory tinning mixture consists of an alloy of 50 parts lead and 50 parts tin. The backing metal is then run in; a useful alloy for this purpose consists of 90 parts lead, 6 parts antimony, and 4 parts of tin. Wood's alloy is sometimes used, but is too expensive for ordinary practice. It consists of an alloy of lead, tin, cadmium, and bismuth, and melts below the temperature of boiling water.

A complete copy of a medal can be obtained by depositing the metal first on one side and then on the other. The two shells thus obtained are, after tinning,

Fig. 3.

placed back to back and the fusible alloy run in between them. After filing and polishing the edges, copper can be deposited on the rim when the whole—reproduced—medal appears to be composed of copper. Fig. 2, A and B, shows a photograph of two sides of a medal commemorating the French revolution, and reproduced in the above manner. The original medal was in this case coated with sulphide. It is seen that by the above method even the faintest lines are reproduced, and we are thus able to obtain an absolutely exact replica of medallions or engravings.

Another and more commonly employed method is to make a cast or matrix of the object which it is desired to reproduce. This may be done in a variety of ways. Sometimes a metallic cast is made directly from the die, and upon this cast a thin film of copper is deposited. Fig. 3 shows such a reproduction which was cast in soft metal, then thinly coated with copper and treated so as to give it the appearance of bronze. The medal appears, in fact, exactly as if it was made of bronze.

Another method, and the most usual, is to prepare a plaster cast and render this impervious to water by impregnating it with melted paraffin, after which the surface is coated with graphite to make it able to conduct the electric current. Sometimes instead of

Fig. 4.

graphitising, it is coated with a thin film of silver by chemical means. After having been rendered conducting, the cast is made the cathode in a plating bath and metal deposited as already described. When a suffi-

Fig. 5.

ciently thick deposit has been produced the cast is taken out of the bath, the deposited metal removed and backed up as already described. The deposited metal gives a faithful reproduction of the original medal. Fig. 4 was reproduced from a plaster cast.

Instead of using plaster to make the cast, gutta-percha or mixtures of gutta-percha and other substances are often employed. Fig. 5 is rather interesting. It was made from a gutta impression. Happening to be short of gutta, my assistant, Mr. W. C. Prebble, to whom my thanks are due for preparing the medallions illustrated in this article, produced two golf balls, and the gutta from the interior of these was employed for making the matrix. The gutta was first kneaded in hot water to render it plastic, and then carefully worked on to the medal, after which it was pressed in a letter-press; hydraulic presses are often used on a commercial scale. The matrix so obtained was made conducting with finely-powdered graphite and was then placed in the depositing bath. This medal contained a great amount of detail, and I think it shows how extremely useful a golf ball may be on occasion. On a future occasion further illustrations of the uses and applications of the electric current in reproduction work may be given.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Dr. Russell's Experiments.—The production of the developable condition in silver bromide, when it is exposed to the action of certain clean metals, notably zinc, and other substances such as turpentine, boiled oil, printers' ink, and sections of wood, is still obscure. Dr. Russell has found that a very minute porportion of the vapour of hydrogen peroxide is able to produce a similar effect, and that hydrogen peroxide is produced when many, if not all, of the substances found to be active are exposed to the air, as they are in the experiments. Again, Dr. Russell has shown that whatever it is that affects the plate, it behaves in some ways like a vapour or gas. It appears to be carried along a tube by a current of gas, it creeps over the edges of plates when they are placed with their glass sides towards the active substance, and so on. If this was all that there is to be said, we should probably rest satisfied with the idea that hydrogen peroxide itself is the active agent. But some of the experiments render it difficult to believe that it is only the production of a vapour at the surface of the active substances, which diffuses, as a vapour would diffuse, towards the photographic plate. Dr. Russell himself has several times drawn attention to this difficulty, though latterly he has apparently passed it over, considering that his experiments prove that hydrogen peroxide is the active agent in spite of it.

Dr. Russell has shown that gelatine is not porous; therefore it may be assumed that if a vapour passes through it, it must be absorbed on one side of the gelatine sheet, work through it, and be given off at the other side. He has shown that it does take time to pass through, but the difficulty is that a practically sharp reproduction of the active surface is obtained instead of a considerably blurred image, such as one would expect from an active vapour passing through such an obstruction. Dr. Russell has said "a good

clear picture" is obtained "even with two sheets of gelatine." When there are interposed "even as many as six or more sheets, still the picture of the scratches is distinct." "It is remarkable that such a vapour should readily pass through media such as gelatine, celluloid, etc., and not by mere absorption, but in such a way as to produce a picture of the surface from which it emanated." "The remarkably clear pictures . . which can be produced through a sheet, or even several sheets, of the thin gelatine, proves that the action is not one of mere absorption." In his third paper on the subject, read before the Royal Society, Dr. Russell says, "How then does the peroxide permeate the gelatine? Not by the ordinary process of diffusion, for hydrogen cannot diffuse through it, so that it must be by a process of dissolving, or very feebly combining with the medium, or with a constituent of it, and, thus travelling through, escape on the other side. That the action is of this nature seems rendered probable by the following experiments." These experiments consist in placing a succession of plates, each for twenty minutes, over a solution of hydrogen peroxide covered with a thin sheet of gelatine, and show that the active agent apparently takes time to penetrate the gelatine. The first plate showed no result, the second a slight action, the third still more, and so on. The same kind of action takes place if zinc is used instead of hydrogen peroxide, or celluloid instead of gelatine.

Thus the production of a detailed image, although several sheets of gelatine were interposed between the active substance and the plate, was acknowledged by Dr. Russell as difficult to understand, and he says in another place that it "seemed to prove that the action was not a mere absorption on the one side and a giving out on the other." The effect points to the obvious suggestion that the effective agent is some form of radiant energy. In 1898 I suggested that as all the active substances experimented with in this connection were susceptible of oxidation by mere exposure to air, and as during their vigorous oxidation (combustion) a form of radiant energy which will affect a photographic plate was certainly produced, it might be that the slow oxidation produced a similar form of radiant energy, just as the total heat effect is supposed to be the same whether the oxidation is slow or rapid. I pointed out the relatively enormous exposures given in Dr. Russell's experiments. One ten-thousandth of a second is certainly ample time to produce the developable condition in the silver salt of a gelatine plate when it is exposed to burning zinc, and it seems not unlikely that an exposure of, say, six hours to the slowly oxidising metal should produce a similar effect, for this increase in the time of exposure is equal to the increase of from one second to more than six-and-a-half years.

There have been other opinions expressed, and suggestions offered, with regard to the character of the cause of these effects, and these I propose to refer to next month.

Zambex cameras—flat film changing.—These cameras now being introduced by Messrs. R. and J. Beck, are distinguished by the novel and ingenious method of changing the films. This operation is accomplished by opening wide the solid hinged lid at the back of the camera, so that the zambex envelope, which is rather more than twice the length of the film, is opened out flat and to its full length. A numbered tab, corresponding to the exposed film, is then firmly drawn along away from its position in front of the bundle until it is in that part of the envelope that is attached to the lid. This leaves the next film ready for exposure, the lid, of course, being first closed. The film carriers are pieces of moderately stiff black paper with projecting tabs to pull them by, and they are attached to one another by thinner paper that rolls over as each is drawn along, and so prevents any friction against the surface of the next film. If it is desired to focus, the exposed films may be pushed back into their original position, and the envelope with its whole charge removed to make room for the screen. On replacing the arrangement for the next exposure the exposed films are drawn up again. When the last is exposed, the film carriers are all pushed back, and the envelope, with its contents in the same relative positions as before use, is removed to make room for a new one. The zambex skeleton, or series of carriers, in its envelope, may be obtained loaded with films, and then all the changing operations are done in daylight; they are also supplied empty, that the user may charge them with any films preferred. The skeletons may be used five times if desired, being provided with five holes to take a staple that retains all except the one that is being removed from the front. Zambex skeletons are also made to carry three plates instead of twelve films. The advantages of this new device are obvious. Each envelope with its full charge is less than half an inch thick, so that the packages are compact as well as light.

The Piesmic Barometer.

A new mercurial barometer, which has been designed by Mr. A. S. Davis, M.A., and has been called by him the Piesmic barometer, is an ingenious adaptation of an easily understood principle in the relation between pressure and volume in gases; and presents as practical advantages several new features of convenience, lightness, and trustworthiness. The action of the instrument depends on the fact that any volume of air taken at a low pressure, is more compressed than an equal volume of air taken at a higher pressure, when the pressure on each volume is increased by the same amount. The following is a description of the method of the instrument, which is of so convenient a size that it could, without very much inconvenience, be carried in the inner pocket of an overcoat.

ABC is a glass tube, the part *AB* being made of strong capillary tubing of one-tenth inch bore and *BC* being made of thin quill tubing. *AB* is seven inches long, and the capacity of the whole tube is 35 times the capacity of a single inch of the capillary tubing. The end *A* opens into a small cast-iron cistern *E* containing mercury. The air in this cistern, though not in actual communication with the external air, is kept at atmospheric pressure by communication with a small auxiliary chamber, the sides of which are of thin paraffined paper. When the tube is horizontal the mercury lies on one side of the cistern, leaving the open end *A* of the tube exposed to the air. When the tube is brought into a vertical position the mercury flows over and closes the mouth of the tube, then flows down the tube to a greater or less depth, the depth being dependent upon the atmospheric pressure at the time. If the barometer is standing at 30 inches the mercury will descend five inches; if at 29 inches it will descend six inches; if at 28 inches, seven inches, and so on. A scale of inches being placed behind the tube, the reading of the end of the mercury column against this scale shows the height of the barometer at the time.

NOTES

ASTRONOMICAL.

Professor Shaler's Comparison of the Features of the Earth and the Moon.

IN Volume XXXIV. of the "Smithsonian Contributions to Knowledge," Professor Shaler, of Harvard University, treats of the lunar features from the point of view of a geologist. He divides them into the broad classes of Maria, vulcanoids (in which apt term he includes all cup-like formations from the greatest ring plains to the smallest crater bed), reliefs (mountains or ridges), valleys and rills, and rays. He discusses and rejects the hypothesis that all or any of the vulcanoids were originated by meteor falls. Were such the cause the bolide would not only have been itself vaporised by the heat of collision, but the surface round, for many times its diameter, would have been melted, and the lava so formed would have been extremely fluid and more than sufficient to fill up the pit caused by the entrance of the bolide. Neither have we evidence on the earth of such numerous and great meteor falls as would be necessary to account for the great number of lunar craters. Though the lunar vents indicate some process of eruption it is evident that this cannot be identical with that on the earth. Terrestrial volcanoes are due—at least mainly—to water buried by aqueous sedimentation, and such occluded water, or its dissociated gases, we cannot admit upon the moon. Professor Shaler suggests some kind of boiling, such as will take place in any fluid mass which is heated below and cooled on the surface (as in molten iron), where substances in the vaporous state, though they exist, are not present in sufficient quantities greatly to affect the movement, or there is a circulation mainly impelled by the escape of imprisoned vapours.

* * *

But the Maria are attributed by Professor Shaler to the fall of great bolides, though many of the arguments, which caused him to reject this as the origin of the vulcanoids, hold good. Besides the Maria are arranged in such symmetrical fashion, almost exclusively in the moon's northern hemisphere, that it seems impossible to consider them as owing their origin to such haphazard casualties as a meteor fall. Professor Shaler considers that the low ridges which extend for many miles across the Maria are more nearly analogous to terrestrial mountain chains than the rugged reliefs which are usually called mountains on the moon. The light rays, he considers, owe their hue and brightness under a high sun to a crystalline deposit which reflects sunlight chiefly when vertical. This is almost proved by their shining also under earthshine, and the bright patches are probably of the same nature.

* * *

The problems raised are numerous, and Professor Shaler states several in a manner that may help to their solution. As regards the vexed question of change on the moon, he strongly decides against the possibility of present volcanic action. If Linné has changed he attributes it to the creeping action caused by the great changes of temperature, assisted perhaps by a blow from a chance meteor. As to the presence of organic life, he points out that there is none at all on terrestrial mountain peaks above 20,000 feet, where the earth's atmosphere is but one-third its density at the surface. Organic life has failed to adapt itself here to the conditions, much less could it originate. How then can we conceive of it on the moon?

* * *

For one problem he can suggest no solution. If meteoric dust falls on the moon in the same proportion as on the earth—and we have no reason to suppose otherwise—and during past time in as great quantities as now—and we have no reason to suppose that it was less—how is it that the moon, unprotected by any atmosphere, has preserved its clean reliefs and its varied hues, and has not had all masked under a uniform veil? Especially how is it that the bright rays differing widely in the date of their origins—which seem but stains on the surface, are still bright, and the older rays no less bright than the later?

* * *

Return of Tempel's Second Periodical Comet.

Three short-period comets belonging to the Jupiter family were discovered by Herr Tempel. Of these the one discovered in 1873 has the shortest period, and was due to return to perihelion this year. It was re-detected by M. Javelle with the 30-inch refractor of the Nice Observatory on November 30, though it was of the most extreme faintness, and set within three hours after the Sun. It appears to have been seen only on two nights, but the observations show a most gratifying precision in M. Coniel's ephemeris; the error being only four seconds of time in R.A. and four seconds of arc in declination. But for M. Javelle's two observations the comet would probably not have been seen at this return at all. Its previous appearances were in the years 1873, 1878, 1894 and 1899; the returns of 1883 and 1889 having been unobserved.

* * *

Discovery of a New Comet.

A new comet, about the 11th magnitude in brightness, was discovered on December 17 by M. Giacobini, of the Nice Observatory, just on the borders of the two constellations of Hercules and Corona Borealis. It was a morning object, moving in a north-easterly direction. It will not become at all a conspicuous object, as the following elements show:—

$$
\begin{array}{ll}
T & 1905 \text{ Jan. 3d., } 2814, \text{ Berlin M.T.} \\
\left.\begin{array}{l} \omega = 75^\circ\ 9'{\cdot}8 \\ \Omega = 225\quad 1{\cdot}2 \\ \iota = 103\quad 27{\cdot}3 \end{array}\right\} & 1904{\cdot}0 \\
\log q & 0{\cdot}27173
\end{array}
$$

The inclination being very great and the motion retrograde, it is exceedingly unlikely that the comet is a periodic one. Its perihelion distance is large, lying much outside the orbit of Mars.

* * *

The Great Red Spot of Jupiter.

In *Astronomische Nachrichten*, No. 3983, there are two interesting notes on Jupiter's great red spot, by the experienced observers, Mr. A. Stanley Williams and Mr. W. F. Denning. The two notes are all the more interesting in that they seem to indicate very different results. Mr. Stanley Williams gives the value for the relative period of the spot as 9h. 55m. 41·52s. in 1903 from 485 observations, as compared with 9h. 55m. 39·66s. in 1902, and writes: "This is a remarkable increase from the value obtained in the preceding year. The changes during the past five years have, in fact, been very considerable. . . Such large and comparatively sudden changes are particularly interesting in the case of an object like the red spot, since in conjunction with its unchanged aspect they appear to indicate, firstly, the relatively great rigidity or solidity (using this word in a comparative sense) of the spot itself, and secondly the mobility of the material surrounding it, and in which it appears to float. There was no noticeable change either in shape or appearance last year, though, owing to the higher altitude of the planet the spot was a comparatively easy object, and its outline could be distinguished without difficulty. There may, however, have been a slight real increase of plainness."

Mr. Denning, on the other hand, finds for the rotation period during the last seven months, 9h. 55m. 38·6s., which, he writes, "is shorter than any period it has exhibited since 1883. In 1883 it was 9h. 55m. 38·2s., and in 1884 9h. 55m. 39·0s. The spot is now very faint. Its variable motion in recent years has been very curious, and it will be highly interesting to watch this object during ensuing months, and trace out any further changes in velocity."

Refraction in Planetary Occultations.

A lunar occultation is usually an instantaneous phenomenon, the moon possessing no atmosphere sufficient to cause a sensible refraction of the light of the star occulted. But several of the planets evidently possess considerable atmospheres, and it might at first sight be expected that an occultation of a star by one of them should show a noticeable effect; a retardation of the disappearance and an acceleration of the reappearance. Dr. T. J. J. See in No. 3984 of the *Astronomiche Nachrichten* shows that in general there is a zone of irradiation round the disc of a planet many times the greatest admissible depth of the atmosphere. A daylight occultation would be free from this irradiation effect, but the observation of such an event under good conditions must be most rare; whilst in an occultation at the dark limb in the case of Mars or Venus the limb of the planet would be unseen, and "it is difficult to see how any result of value could be obtained."

* * *

The Greenwich-Paris Longitude.

M. Loewy, in a communication to the Paris Académie des Sciences gives the final result of the determination of the difference of longitude between the two Observatories which was carried out by MM. Bigourdan and Lancelin in 1902. Some small differences were noted between the values obtained in September, 1902, and those in April and May, which are ascribed to slight changes in personal equation. The mean result gives the difference of longitude as 9m. 20·974s., the value found independently by the two English observers, Messrs. Dyson and Hollis, being 9m. 20·94s.; a difference of only the thirtieth of a second of time. The difference of longitude between the two meridians may therefore be considered as now known with most gratifying precision.

* * *

Sunspot Spectra.

The Rev. A. L. Cortie, S.J., gives in the *Astrophysical Journal* for November an interesting summary of his observations of sunspot spectra during the years 1883-1901. His spectroscope was an automatic twelve-prism instrument by Browning, each prism being of 60 refracting angle. The region examined was the red and yellow; from B to D; and 349 lines are contained in the catalogue of widened lines—the individual observations being 5486 in number.

The summary of results shows the important part played by the faint lines of vanadium and titanium in the spectra of sunspots. Lines which in the earlier observations were classed as of unknown origin have since been found to be due to vanadium or titanium. These faint lines are always at all times of the sunspot period among the most widened lines; λ 6243·06 of vanadium being particularly noticeable. Father Cortie finds no evidence of the "crossing points" when these vanadium and titanium lines give way to lines of iron, such as Sir Norman Lockyer has insisted upon so strongly; nor is he inclined to admit that there is warrant for concluding that there is an essential difference of character or temperature between maximum and minimum spots. He regards the widening of some of the oxygen lines, especially in the *a* band, as a real phenomenon, but considers that the apparent evidence for the widening of lines accredited to water vapour requires support from further research before it can be definitely received.

* * *

The Astronomical and Scientific Bequests of Mr. Frank McClean.

Mr. Frank McClean, F.R.S., has made the following bequests: £5000 to the University of Cambridge, to be expended in improving the instrumental equipment of the Newall Observatory; £5000 to the University of Birmingham for physical science; £2000 to the Royal Society; £2000 to the Royal Astronomical Observatory; £2000 to the Royal Institution; and to the University of Cambridge, for presentation to the Fitzwilliam Museum, all the testator's illuminated or other manuscripts and early printed books, and all objects of mediæval or early art which the Director of the Museum may select as being of permanent interest to the Museum.

The Medals Awarded by the Royal Society.

The Copley Medal has been awarded to Sir William Crookes for his experimental researches in chemistry; the Rumford Medal to Professor Ernest Rutherford for his researches on the properties of radio-active matter; one Royal Medal to Professor W. Burnside, on the ground of the number, originality, and importance of his contributions to mathematical science; the other Royal Medal to Colonel David Bruce for his successful researches into the causation of a number of important diseases affecting man and animals; the Davy Medal to Professor W. H. Perkin, jun., for his researches in the domain of synthetic organic chemistry; the Darwin Medal to Mr. William Bateson for his researches on heredity and variation; the Sylvester Medal to Professor Georg Cantor for his researches in pure mathematics; and the Hughes Medal to Sir Joseph Swan for his invention of the incandescent electric lamp and his other inventions and improvements in the practical applications of electricity.

BOTANICAL.

By S. A. SKAN.

It is announced in the December number of the *Botanical Magazine* that Sir J. D. Hooker, who has been the editor of this famous periodical for the long term of forty years, retires from that position with the completion of the volume for 1904, on account of his great age, Sir Joseph now being in his eighty-eighth year. It is further stated that a new series begins in January, 1905, with Sir William Thiselton-Dyer, K.C.M.G., Director of the Royal Botanic Gardens, Kew, as editor. For some time past Mr. W. Botting Hemsley, F.R.S., has given Sir J. D. Hooker a great deal of assistance in carrying on the work, most of the text in the last volume having been contributed by him. The *Botanical Magazine* has now appeared uninterruptedly for 118 years. Mr. Hemsley, in his interesting history of the work, which was published in the *Gardeners' Chronicle* in 1887, refers to it as "having long outlived the numerous rivals and imitators which its successful career gave rise to from time to time. Indeed, it is doubtful if it is not the only illustrated serial ever published that has enjoyed a century of unbroken vitality."

* * *

In the *Comptes Rendus*, Vol. CXXXVIII., p. 293, Messrs. Bouilhac and Giustiniani have an interesting article on the important question of the utilisation of free nitrogen by various higher plants through the medium of certain freshwater algæ (*Nostoc punctiforme* and *Anabæna*) associated with bacteria. Nitrogen, one of the essential constituents of plant food—the development of proteid substances depending on its presence—though so abundant in the atmosphere, is shown by experimenters, amongst whom may be mentioned De Saussure, Boussingault, Lawes and Gilbert, to be inaccessible to plants in its uncombined state, and that the majority of them are dependent for their supply of the gas to nitrogenous manures incorporated with the soil in reach of their roots. Leguminosæ are remarkable in being able to make use of the atmospheric nitrogen, which is fixed and rendered diffusible for them by the agency of bacteria infesting the nodules often found in abundance on their roots. The writers referred to at the beginning of this note show that other plants besides Leguminosæ, such as buckwheat, mustard, cress and maize, will thrive when the source of nitrogenous food is restricted to the nitrogen of the air, so long as certain algæ and bacteria are present in the soil. These appear to be able to convert the gas into a form accessible to the plant in the same way as do the bacteria in the root-nodules of the Leguminosæ. Messrs. Dehérain and Demoussy had previously ascertained that even a leguminous plant (*Lupinus*) would flourish in soil deprived of nitrogenous ingredients, and without developing nodules on its roots, if algæ were present.

ORNITHOLOGICAL.

By W. P. Pycraft.

Breeding Habits of Pterocles Exustus.

Mr. W. H. St. Quintin, in the December number of the *Avicultural Magazine*, gives an exceedingly interesting account of the habits of the greater Pintailed Sandgrouse (*Pterocles exustus*), which he has succeeded in breeding in his aviary this year—the first record of the kind in this country.

In the course of his essay he describes the curious method which the birds have of watering their young. As this is probably new to most of our readers we venture to reproduce it here. "The young," he says, "no doubt are somehow able to make it clear to their male parent that they wish to drink, and he starts off to the pan, and, after sipping a little on his own account, steps in and stands motionless for a minute or two watching. Then he sits down in the water, and goes through a shuffling movement very like a bird that is dusting. After remaining in the water several minutes he gets out and hurries off loudly calling to the young, who, if old enough, run to meet him. Then follows what reminds me more than anything of a mammal suckling her young; the chicks push their heads amongst the breast-plumage and under tail-coverts, evidently taking the water off the feathers by passing them through their bills, moving to fresh places as the supply becomes exhausted."

Pterocles alchatus has the same custom; a fact first noticed by Mr. Meade-Waldo. As in the species just described, only the male undertakes this work.

The habits of these birds in confinement thus throws unexpected light on certain peculiar habits seen in wild birds of these species and the allied *Pterocles arenarius*, which were observed by Mr. Meade-Waldo soaking their breasts in puddles about the village wells in Morocco and then flying off.

* * *

Breeding Colonies of the Flamingo.

In a charming and beautifully illustrated article in the *Century* for December, Mr. Frank Chapman describes the breeding habits of the Rosy Flamingo (*Phœnicopterus ruber*). His observations were made in the Bahamas; and since but little is known of the breeding habits of Flamingos, his account will be eagerly read by ornithologists.

If any doubt still lingers in the mind of any of our readers as to the truth of the old story of the method of incubation which these birds, on account of the great length of their legs, were obliged to adopt—brooding the eggs by sitting astride the nest!—they should be dispelled by Mr. Chapman's photographs.

In view of the opinions which have been expressed as to the systematic position of the Flamingo, it is interesting to notice that the young are goose-like rather than stork-like, inasmuch as they are precocious. Nevertheless, unless suddenly alarmed, they remain in the nest for a few days after hatching, and are fed by the parents on what is described by the author as "regurgitated clam broth," which is taken, drip by drip, from the parent's bill. It would seem, however, from the author's description that only their first meal is of this character, and that henceforth the birds feed themselves under the parents' guidance. Thus, in this matter, they further resemble the Anseres.

Unfortunately, owing to the unavoidable publicity which Mr. Chapman's search for these birds occasioned, this huge colony is doomed to extinction. Hitherto undiscovered, its whereabouts has now become known to the negroes of the island. And as fresh meat is "rarer then pink pearls" in the outer Bahamas, and young Flamingos are regarded as excellent eating, a relentless war on the colony has begun.

* * *

Sabine's Snipe in Cambridgeshire.

A remarkably fine specimen of the so-called Sabine's snipe was killed in November at Fulborn, Cambridge, on the estate of Captain Tryon.

Now known to be only a melanistic variety of the common snipe, this bird yet presents some striking points of difference from the normal type. Though I have recently examined several specimens, in none have I remarked the characteristic longitudinal striping on the upper parts, or the bars on the axillaries.

The present bird, a female, may be described as velvety black above, relieved by brown markings, forming horse-shoe shaped bars at the tips of the feathers of the scapulars and mantle. The dark colour around the face was so intense as to form a sort of mask, comparable in area to that of the black-headed gull in summer dress. The beak and feet were of the normal colour.

Only in a few rare instances has the sex of these varieties been recorded, though between fifty and sixty examples are known. Of these, thirty-one have been obtained in Ireland, twenty-two in England—the present specimen makes the twenty-third—one in Scotland, and one in France.

This appears to be the first record for Cambridgeshire.

* * *

The Thrush-Nightingale in England.

The first authentic British-killed example of the thrush-nightingale (*Daulias philomela*) was obtained at Smeeth, Kent, on October 22, and was exhibited at the British Ornithologists' Club on November 16. It proved to be a male.

Known in Germany as the "Sprosser" nightingale, this species differs from the common nightingale in its somewhat larger size and the presence of faint spots on the throat; but it is inferior as a songster, as compared with its smaller relative.

* * *

Water Pipits at Rye Harbour.

An immature male water-pipit (*Anthus spipoletta*) was shot at Rye Harbour, Sussex, on October 26, 1904. It was procured out of a flock of rock-pipits. On November 19, a female, also an immature specimen, was killed at Pevensey Sluice, Sussex.

Mr. M. J. Nicoll, who exhibited these birds at the November meeting of the Ornithologists' Club, remarked that he had but little doubt that the water-pipit was a regular visitor to England during the autumn migration, but escaped notice owing to its resemblance to the rock-pipit.

They seem to prefer salt and brackish pools as a feeding ground.

* * *

Spotted Crake in Co. Antrim.

A young female Spotted Crake (*Porzana maruetta*) was killed on October 8 at Templepatrick, Co. Antrim. This makes the sixth occurrence of this species in Co. Antrim.

* * *

Immigration of Lapland Buntings.

A small flock, at least, of Lapland Buntings (*Plectrophanes lapponica*) would seem to have reached our shores this autumn, inasmuch as a bird of this species was taken in a trap at Acock Green, near Birmingham, on November 21; and two on the denes at Great Yarmouth, a female on the 18th and a young male on the 24th of November.

* * *

Hoopoe in Cheshire.

An immature Hoopoe was, records the *Zoologist*, shot in a potato field at Sale, Cheshire, on September 21. This bird had been seen in the neighbourhood since the 17th, and was very tame—a trait which unfortunately cost the wretched bird its life! These birds would undoubtedly breed in this country if left alone when they arrive in the spring, as many do.

* * *

Black-necked Grebe breeding in Great Britain.

Mr. O. Aplin has a most interesting account of the breeding of five pairs of the Black-necked Grebe (*Podicipes nigricollis*) on a lake, the geographical position of which he most wisely refuses to disclose. His notes contain some valuable observations on the habits of the old birds and their care of the nestlings.

Although these birds have been suspected of breeding more than once on the Norfolk Broads, and perhaps in Ireland, no satisfactory proof thereof has ever been brought forward.

* * *

Oyster-Catcher Swimming.

In the *Irish Naturalist* for December Mr. C. J. Patten gives a long account of an Oyster-Catcher which, on finding itself observed when feeding along the water's edge, raced along the beach and, taking to the water, swam out to sea for a distance of 200 yards. Later, on its return to land, he succeeded in heading it off and running it down, when he found that one wing had been injured, apparently some days previously. The bird is now in the Dublin Zoo.

ZOOLOGICAL.

By R. LYDEKKER.

Black Foxes.

ACCORDING to the Norfolk *Weekly Standard* of October 22, a litter of black foxes was bred last spring in the Bedale country, on the estate formerly belonging to the late Duke of Cleveland. If authentic, this event would appear to be unprecedented, but, as has been recently pointed out by a writer in the *Field*, young foxes are normally slate-coloured, and the statement may be based on this fact. Be this as it may, Mr. J. E. Millais, in the first volume of his magnificent new work on "British Mammals," after mentioning that a tendency to melanism is by no means uncommon in the species, records only two instances of completely black foxes. The first of these occurred in the New Forest, and is referred to in the *Zoologist* for 1890, the second was reported from Leicestershire in 1903. The old legend that to hunt a black fox implied certain death to the pursuer indicates, however, the occurrence of such instances in former years. In this connection it may be noted that a writer in the November number of the *Zoologist* states that both melanistic and albino animals are generally inferior in size to their normally coloured fellows.

* * *

The Fallow Deer as a British Fossil.

In the course of a paper on the contents of a Derbyshire cavern read before the Geological Society on November 23, the authors, Messrs. A. Bembrose and E. T. Newton, referred to a large number of remains which they identified as belonging to the fallow deer. These were stated to have been found with those of undoubted Pleistocene mammals at all horizons in the cavern strata. Now, fallow deer remains have hitherto been unknown from any Pleistocene British cave; and since fallow deer are just the kind of animals whose carcases would be carried into caves by hyænas, it was argued in the discussion which followed the reading of the paper that if their remains are absent from all other cavern-fauna, they are not likely to occur in this one. The argument is no doubt a strong one, but if the remains are rightly identified (and this was not disputed) it seems difficult to account for their occurrence among the Pleistocene remains, otherwise than according to the views of the authors of the paper. It may be added that numerous fallow deer remains have been described from the peat of Denmark.

* * *

The Whales of the N.W. Atlantic.

Important whale fisheries have been established of late years on the coast of Newfoundland, and the enormous amount of material thus made available to the naturalist has been taken advantage of by Mr. F. W. True, an American zoologist who has devoted special attention to the study of this group of the cetacea. The results of his investigations have recently been published at Washington by the Smithsonian Institution in a quarto volume, illustrated by no less than 50 plates showing the carcases of whales as they are landed at the Newfoundland factories. Five or six different kinds of whales are taken at the establishment, of which the great majority (both as regards species and individuals) are rorquals, or finners, of the genus *Balænoptera*, that is to say, whales with short whalebone, and of a long and slender shape, adapted for swimming at a great pace. A certain number of humpbacks (*Megaptera*) are, however, captured, while occasionally a sperm-whale (*Physeter macrocephalus*), and, still more rarely, a Biscay right-whale is taken. All the species met with on the American coast seem identical with those found on our own side of the Atlantic. The most abundant is the common rorqual, whose scientific title (*Balænoptera musculus*) the author seeks to transfer to the "sulphur-botlarn," generally known as *B. sibbaldi*. Apart from the rights of the case, such a shifting of well-established names can have no possible advantage, and must inevitably lead to confusion.

* * *

Deaths from Snake-Bite and Wild Beasts.

The mortality in India due to the attacks of wild beasts and snake-bite, according to the Government returns for 1903, maintains its usual appalling magnitude, showing, indeed, an actual increase in some items, although there is a decrease under other headings. The total mortality among human beings reported to have been caused by wild beasts during the year was 2749, against 2536 in 1902; the increase being largest in Madras (236) and the United Provinces (90). The destruction of life by tigers was, however, considerably less than during the previous year, the number being 866, against 1046; the greatest decrease in this item being in Bombay, while Madras showed an increase. On the other hand, the deaths from wolves rose from 338 in 1902 to 463 in 1903; the great bulk of these being attributed to a few which have taken to man-eating. The deaths from snake-bite fell from 23,167 in 1902 to 21,827 in 1903; Bengal alone accounting for 10,394. Of the remainder, 4964 deaths are credited to the United Provinces, 2011 to Madras, 1008 to Bombay, 1031 to Burma, and 1386 to the Central Provinces.

* * *

The Old Rhinoceros at the "Zoo."

At the time of writing these Notes, the Indian rhinoceros presented to the Zoological Society by the late Mr. A. Grote, on July 25, 1864, was reported to be in a moribund condition. This animal affords a wonderful instance of longevity in captivity. It has since died.

* * *

The First Fruits of the "Discovery's" Voyage.

The first description of a new animal "discovered during the voyage of the *Discovery*" is apparently one in the December number of the *Annals and Magazine of Natural History*. In this Mr. T. V. Hodgson gives a preliminary notice of a peculiar type of "pycnogonid," or "sea-spider," distinguished from all its relatives by the presence of an additional pair of legs, which brings up the number to five. On this account, although it is admittedly very close in other respects to the well-known *Nymphon*, the new form is made the type of a genus by itself, under the title of *Pentanymphon antarcticus*.

* * *

Papers Read.

At the meeting of the Geological Society on November 23, Messrs. Bembrose and Newton communicated a paper on the contents of a Derbyshire cavern, to which fuller reference is made in an earlier paragraph; the Ammonites of the group *Lytoceratidæ* formed the subject of a communication by Mr. S. S. Buckman at the meeting of December 7. At the meeting of the Linnean Society on November 13, Mr. G. B. Buckton described certain hemipterous insects of the family *Membracidæ*. Captain Crawshay, at the meeting of the Zoological Society on November 29, communicated some notes on the habits of the lion; and the sixth part of Sir C. Eliot's contributions to our knowledge of the nudibranch molluscs of East Africa was also taken. Mr. Lydekker, in addition to describing certain forms of loris, or oriental lemurs, exhibited photographs of paintings of animals in the possession of H. M. the King at Windsor Castle. The other papers included one by Dr. Hagen on certain crustaceans, one by Mr. Boulenger and another by Mr. Beddard on lizards, and a fourth by Mr. Gurney on South African entomostracous crustaceans.

Heredity.

By J. C. SHENSTONE, F.L.S.

I.

It is now three centuries since "Gilbert" of Colchester taught us to practise the method of reasoning from observation and experiment. Since his day, hosts of workers have attacked natural phenomena by inductive methods, and with such success that the present state of knowledge in chemistry and in physics affords us reasonable ground for hoping that before long equal progress may be made in the study of plants and animals. It may, therefore, interest the readers to consider what advance has been made in the latter branches of knowledge.

I have selected "Heredity" as the subject of this article because it is peculiarly identified with living things, and because it is a subject of such importance to the human race that it appeals to us more forcibly than any other branch of enquiry.

The origin of our domesticated animals and of wheat and barley are lost in antiquity; these must have been obtained at some very remote period, by a gradual process of cultivation and artificial selection from wild animals and wild plants, the varieties best suited to man's requirements having been selected for the production of the food supplies required by early men. We also find the ancestry of men carefully traced in the Biblical and other very early records; we may therefore conclude that heredity attracted attention as far back as history carries us. But the knowledge of our ancestors was confused with much error, and no solid advance towards discovering the principles of heredity was possible until the great Swedish naturalist, Linnæus, had classified and arranged all known forms of plants. Linnæus was the first to realise the discord and confusion which existed in our knowledge of plants and animals until his time. And he clearly perceived that there must be a natural system which, however, could not be determined until the rules underlying Nature's own system had first been discovered. In order to enable students to search for these rules, he described and classified provisionally all known forms of plants. His system was, it is true, an artificial system; it was not founded upon actual relationship existing amongst the members included in his various groups, nevertheless it enabled naturalists to clearly indicate any particular plant to which their investigations referred, and thus removed the great difficulty which had previously existed of communicating botanical knowledge, and opened the way to solid advance towards a complete knowledge of plants and animals.

After Linnæus, progress was slow, clogged by the dogma known as the "constancy of species": the belief that every form of animal and plant owes its existence to a special act of creation. For at least a century this dogma remained as an article of faith which no naturalist could doubt without losing his scientific reputation, and the belief was strengthened by the fact that it accorded with the tenets of the Churches. This is all the more astonishing when we remember that breeders of animals had long been skilled in moulding their forms to suit the requirements of man, and that the variation of vegetables by cultivation had been practised from a period preceding the advent of Linnæus, the varieties of vegetables, of fruits, etc., being in fact increased almost daily before everyone's eyes, by processes of cultivation. The skill of the early pigeon-fanciers affords a good illustration; and one has but to tell the history of the cultivation of the rose, to show how inconsistent this dogma was with the facts which stare everyone in the face; for we find that whilst Parkinson, one of the earliest writers (1629) upon gardens, only speaks of the red, the white and the damask roses, and Gerard, at the end of the sixteenth century, describes eighteen varieties, John Ray in the seventeenth mentions thirty-seven, whilst a century later no less than seventy-nine varieties were in our gardens; quite early in the nineteenth century the number of varieties of the rose had risen to above two thousand, and to-day they are so numerous that it would be impossible to draw up a complete list. The mania which existed, during the seventeenth century and later, for producing new varieties of tulips by cultivation, affords an equally forcible illustration. Many of these varieties of plants were undoubtedly produced by hybridization; but as any attempt to change the forms of animals and plants was held to be a breach of the Almighty's law, these new varieties were frequently introduced to the public as new plants imported from foreign countries, thus hiding the real facts from the eyes of the public. These historical facts show us how strongly the dogma of the "constancy of species" had become rooted, and perhaps the greatest debt we owe to Chas. Darwin is the destruction of this dogma which had blocked all progress.

I must now introduce to the reader, Christian Konrade Sprengel (1750), for a time rector of Spandau, who, noticing that the honey in the wood cranesbill was hidden by inconspicuous hairs at the lower part of the petals, suggested that the hairs might serve to protect the honey from rain whilst leaving it accessible to insects, an observation which led him to conclude that honey is secreted by flowers for the sake of insects, and ended in his becoming so absorbed in studying the relationship of flowers and insects that he neglected his duties as rector, was removed from his post, and lived thereafter neglected and shunned by men of science as a strange, eccentric person. The book which he published upon plants and insects* met with so little support that he never brought out a second volume. Many years later Chas. Darwin was inspired by this work to investigate the subject, and his investigations resulted not only in considerable additions to Sprengel's work, but led to the complete knowledge of the sexuality of plants, a subject little understood until towards the middle of the last century.

The organs of a flower consist first of a seed vessel containing the undeveloped seed. At the apex of this seed vessel is a viscid surface called the stigma, sometimes, but not always, provided with a stalk. Secondly, of certain little bags of golden dust, the anthers, with which we are all familiar. The yellow granules of which this dust is composed, if they reach the viscid apex of the seed vessel, send minute tubes down to a cell called the "germ-cell" in the young seed and thus fertilise it. Unless the young seed is fertilised, it never matures but presently fades away and dies.

(To be continued.)

*Das entdeckte Geheimniss der Natur in Baue und in der Befruchtung Blumen, 1793.

REVIEWS OF BOOKS.

The Moon.—"A Summary of the Recent Advances in our Knowledge of our Satellite, with a complete photographic atlas," by William H. Pickering, of Harvard College Observatory. (John Murray. Price £2 2s.)

It is the declared intention of the author of this sumptuous volume to give an account of some of the more recent advances in our knowledge of the moon, and to leave to the text-books a statement of that earlier acquired information with which most people are already familiar. This statement of Professor Pickering's intention is not quite fair to his accomplishment; because it might lead the reader to suppose that the book contained only such material as had been already presented in the author's contributions to the Harvard Observatory Annals, whereas the book might best be defined as a brilliantly interesting essay on the moon, coloured or supplemented by Professor Pickering's views of the inferences to be drawn from the latest information concerning it. Thus the first three chapters, written in a vein which will appeal to any intelligent and educated person, comprise the commonly accepted views as to the origin of the moon, the data in regard to its distance, rotation, libration, &c.; and the opinions formed within the last few years by many astronomers on the probable density and temperature of a lunar atmosphere. Some of the new views are hypotheses; some are of a nature more solid than that and are based on the Harvard "discoveries" which the splendid Arequipa station have enabled astronomers to add to the common capital of astronomic science. In another particular new "views" of the moon are presented, for the volume contains a complete photographic atlas of the moon, the plates of which cover the whole visible surface of the moon five times. Eulogy of these beautiful plates is superfluous; they have been made, and they have been selected and printed, with one object alone in view, which is that the Harvard College Observatory, and the expedition which it sent out to Jamaica in 1899 for the special purpose, should have the honour of presenting the most complete and the most scientifically useful set of photographs of the moon in existence. With, or (as Professor Pickering's opponents might say) without, some of the deductions which are drawn from his examination of the moon's surface, they mark a fine achievement, and are an enviable possession. There are nearly a hundred plates in all; and they constitute the only complete lunar atlas in existence. The first point on which Professor Pickering may be said to invite controversy is in respect of the moon's atmosphere, water and temperature. He gives observational grounds for believing that an atmosphere exists at the moon's surface, comparable in density to that which would be found at a height of about 30 to 40 miles above the surface of the earth. A haze, he adds, appears to rise to a height of about three or four miles on the sunlit side of the moon. Accepting Professor Pickering's observations as accurate, what is to be said of his explanation that water and carbonic acid gas are escaping from the moon at such a rate as to constitute an atmosphere of the kind he predicates, or to give rise to permanent snow fields? The opposed view is that the gases in question would escape too quickly from the moon's surface—the force of gravity there being insufficient to retain them—and that some other explanation must be found. Professor Pickering's hypothesis, while explaining with apparent satisfaction that the observed enlargement of the white spots of Linné towards lunar sunset and during a lunar eclipse are due to a sublimation of hoar frost, is peculiarly difficult of application to the systems of bright streaks which radiate from some of the lunar craters, and which are attributed to snow produced by allied causes. Similarly Professor Pickering, from the consideration of the darkening of certain areas of the moon's surface and their increase of size during the lunar morning, together with their disappearance towards the time of sunset, arrives at the conclusion that a luxuriant vegetation springs up on the moon, nourished by water which it derives by capillary force from the soil and fostered by the sun's heat to a giant growth that is aided by the small gravitational attraction of the moon itself. Against this hypothesis, fascinating but fanciful, we have to set the fact that no terrestrial life exists on terrestrial mountains 20,000 feet or more above the sea under atmospheric and thermometric conditions which must be vastly more favourable than those to be found on the moon. Furthermore, as another writer has said, whatever may have been the circumstances which led to the beginning of life on this earth, they were evidently of rare occurrence. The fate of the moon as a habitation for any form of life, as we know it, was probably in large part determined by the ratio between its gravitative force and the energy of the kinetic movement of the gases which constituted its atmosphere. If that energy had been sufficient to keep them on the satellite, there is no reason why it should not have had the history of a miniature earth. These postulates are palpably non-admissible, and it is most reasonable to suppose that the moon has not even vegetable life as we know it. These are, however, only "spots on the moon," and we should not be justified in regarding them as such, were they presented with any less appearance of incontrovertible and established truth, in a volume which is not a controversial work at all, but is clearly intended to inform the growing class of people who, without being experts, are deeply interested in science. If, however, they bear in mind that—to adopt an American expression—all Professor Pickering says does not "go," then in buying and reading this fine work they will be richer by the knowledge of ingenious, interesting, and fascinating theories, as well as by a solid possession of great instructional value.

Game, Shore, and Water Birds of India, with additional references to their allied species in other parts of the world, by Colonel A. E. Le Messurier, C.I.E., F.Z.S., F.G.S., fourth edition (London: Thacker and Co., 1904). Works on the birds of India are not numerous, and sportsmen, as a rule, have found them either too bulky or too technical. That is to say, these works have been designed rather for the ornithological student than the campaigner. Though the standard, in short, of these tomes has been an unusually high one, they are not adapted to the use of men who must travel with as little luggage as may be. Colonel Le Messurier was one of the first to realise this, and so far back as 1874 he prepared a volume, for private circulation only, on the "Game Birds of the Eastern Narra." Four years later—in 1878—this book was issued to the public with some slight alterations. This year was made memorable in the annals of Indian Ornithology by the appearance of the first volume of Hume and Marshall's "Game Birds of India," a work which quickly made its influence felt. Colonel Le Messurier was among the first to realise the sterling value of these volumes, and we find, indeed, that in his next edition he begs to acknowledge that the additions therein made are largely taken from this source. That the author's efforts to produce a handy and portable guide for the use of sportsmen were fully appreciated may be gathered from the fact that a fourth edition has been called for. It is highly probable that this last will meet with as cordial a welcome as the earlier volumes; inasmuch as all the features which secured success for the earlier editions are preserved here, and considerable additions have been made. Viewed, however, from an entirely impartial standpoint, it must be admitted that a great opportunity has been missed in this new volume. There can be no doubt but that the introduction requires drastic alterations. As it stands it is useless alike to the scientific student and to the sportsman, and errors are painfully common. The classification adopted is antiquated. The quotation from Professor Kitchen Parker—unacknowledged, though placed within inverted commas—was more or less true when he wrote it in 1875. But in 30 years much has been done in this matter. On the question of migration, the author relies almost entirely on Professor Newton's masterly article in the ninth edition of the "Encyclopædia Britannica." But, as touching the mysterious irruptions of Pallas's sand-grouse into Great Britain, we would gather that the last of these occurrences took place in 1872! Other equally important matters are treated in the same perfunctory manner. Under a double heading, of ponderous capitals, the question of "External Variation in the Two Sexes and at Different Seasons" is discussed, and dismissed, in three paragraphs of two lines each! The subject of nidification is dealt with in 16 lines! Under the curious plea that, "owing to the facilities of travel, Anglo-Indians are now engaged in most countries either in business or pleasure," the author, in this edition, includes references to "all species in other parts of the world that are allied to the game, shore, and water birds of India." Surely even Anglo-Indians cannot contrive

to be in more than one country at one time, and since we presume their journeys are more or less premeditated, we cannot see why the author should not leave them to select the appropriate books for themselves. His own volume will certainly prove but a broken reed to trust to. It is a pity that matters utterly outside the scope of this book should have been introduced. So far as the sportsman's side is concerned, Colonel Le Messurier's guidance will be confidently followed, for he unquestionably knows his subject. But there can be no doubt that those parts which are admittedly compiled from abstruse scientific treatises, or from the labels in the Natural History Museum at South Kensington, should be ruthlessly suppressed. When they are not inaccurate, and out of date, they are out of place, and worse than useless, because they take up valuable space. An introduction giving a summary of the varied geographical features of India and the peculiarities of the avifauna of the several regions which may be distinguished would have been of immense help. To this might have been added the observations which Colonel Le Messurier must have made in the habits of birds and their relation to the environment. To those about to enter upon civil or military life in India such a chapter would be helpful indeed. A collection of native legends and superstitions concerning the birds of India would have still further added to the value and usefulness of this book. We hope that these things may yet be done. This work is profusely illustrated, but on the whole the figures are about as bad as any it has ever been our lot to criticise. These remarks are made in no spirit of captious criticism, but with a view to make of this work a really valuable, up-to-date guide to the "Game" Birds of India.

"The Cambridge Natural History" (Fishes, Ascidians, &c.), by Various Authors (Macmillan and Co., Limited; price, 17s. net). We have the greatest satisfaction in welcoming the somewhat belated appearance of this long-expected volume, as a trustworthy and up-to-date work on fishes written on more or less popular lines was a desideratum. On the whole, this volume, which is bulkier than any of its fellows, may be said to fulfil what was expected of it; although portions of it, owing to having been set up in type for a considerable time, are a little out of date; and there is a certain amount of disadvantage attending the dual authorship of the portion devoted to fishes, as it is difficult to ascertain to what extent each of the two eminent contributors is responsible for, and approves of, the general systematic arrangement of the members of the class Pisces. Before going further, it should however, be mentioned that the relegation of the sections dealing with the lower chordates to authors other than those responsible for the fishes was quite a proper, and indeed essential, proceeding; and we may congratulate Professors Harmer and Herdman on the very excellent and exhaustive manner in which they have severally treated their sections of the subject. As regards the fishes, while Professor Bridge, of Birmingham, has undertaken the morphological part of the subject together with much of the systematic work, the taxonomy of the modern bony fishes and their immediate extinct relatives has fallen to the share of Mr. Boulenger, the fish-expert of the British Museum. His rearrangement of these fishes (which has already been published in the *Annals and Magazine of Natural History*) considerably modifies previous conceptions as to the mutual relationships of some of the groups, and may be regarded as a distinct advance in systematic natural history. As a small instance of the want of uniformity due to divided authorship, we may refer to the two family names *Osteolepidæ* and *Leptolepididæ*. As regards Mr. Bridge's contribution, it cannot fail to be noticed that the morphological side receives much fuller treatment than is accorded to the systematic section—a by no means unmixed advantage, we venture to think, in what is supposed to be, in great measure, a popular work. The chief feature in the taxonomy whereby this part of the work differs from many treatises now in use is the inclusion of the chimæras and their allies (*Chimæroidei*) in the same group with the sharks and rays (*Elasmobranchii*). The essential difference in the structure of the skull of the two groups is, in Mr. Bridge's opinion, an adaptive feature, due perhaps to the great development of the structures which serve the function of teeth in fishes of this group. We are inclined to think that the author may be right in his view; and we should be still more disposed to endorse his scheme if the chimæroids were not such an ancient group. In the suppression of the term *Actinopterygii* for the whole of the fan-finned teleostomous fishes, as opposed to the group *Crossopterygii* for the bichir and its relatives, we cannot think the author (or authors) has been well advised. Moreover, we regret to see the familiar name *Cestracion* of the Port Jackson shark displaced by *Heterodontus*, especially as we ourselves consider the use of the latter term barred by the existence of the name *Heterodon*. As a whole, however, we cannot but express our opinion of the high scientific value of the latest volume of the excellent *Cambridge Natural History*.

"A Later Pepys," by Alice C. C. Gaussen (John Lane, 2 vols.). There was another Pepys, who followed him, and who, in the opinion of his time, as well as of his polite friends, was a much more distinguished person than the immortal Diarist. He was Sir William Pepys, Master in Chancery, born in 1740, and by reason of his great literary abilities, and his personal charm, the associate and correspondent of many who formed what we should call the literary circle of the latter part of the eighteenth century. His letters to Hannah More, Mrs. Montagu, Mr. James McDonald, Major Rennell, Sir Nathaniel Wraxall, have been preserved, and, collected in these volumes, form a very interesting and valuable record of the thoughts, manners, and conversation of these times. We should, perhaps, say now that Sir William was flattered by knowing "the best people"; but if he was proud of their intimacy and converse, they were no less proud of his, for he seems to have been emphatically one of those Men of the Time who, like others in our own day and generation, create an impression that much higher achievement was in their powers than they ever put forth their energies to grasp. However that may be, Sir William Pepys was a distinguished, amiable gentleman, to whose accomplishments his biographer's handsome volumes do ample justice. The only fault we have to find is that the letters, instead of being arranged chronologically, are grouped under the persons to whom they were addressed.

Who's Who.—One might say of the yearly publication of "Who's Who" (A. & C. Black), as already has been said of London's service of messenger boys, that we cannot imagine how the world ever managed without it. It is as indispensable to the journalist or the man of business as a rhyming dictionary is to a poet, or a "Thesaurus" to a neophyte in letters, and we feel something of the same gratitude for its unfailing readiness to supply information as we experience towards such benefactors of the public as the postman or the City policeman. It is, to speak seriously, an extremely useful and an extremely well-edited work; it contains 17,000 biographies on its 2,000 pages, and it is, take it for all in all, the cheapest seven-and-sixpenny-worth that is published. It is the Biographical Directory of the working professional man.

Whitaker's.—There is no new thing to be said of "Whitaker's Almanack," which, with the neat, concise, and handy "Whitaker's Peerage," makes its unfailing appearance at this time of year, for even if one were to say that it possesses several new features this year, one would but be repeating an observation which is true of it every year. Speaking from the point of view of a scientific review we should welcome a little more attention to science, or to the scientific aspects of industry, among its able summaries. But one cannot expect everything within its covers; and the information which is given is remarkable for its usefulness, its universality, its just proportions, and its unblemished accuracy.

The Englishwoman's Year Book.—This is a publication which, like "Who's Who," is published by Messrs. A. & C. Black, and is gaining for itself with some rapidity the same position of indispensability. Nothing that concerns women, especially working women, is alien to it; and we can suggest no improvement beyond the addition of a more characteristic calendar. The calendars, we think, might well embrace the birthdays of famous women.

X-Ray and Electro-Physical Apparatus.—Mr. A. C. Cossor, of 54, Farringdon Road, has sent us a copy of his recently-issued list, covering the various specialities manufactured by him. Beyond X-ray and allied apparatus the catalogue comprises many articles of use or interest to the worker on the physical side of science. We are glad to notice that there are several scientifically trained assistants on the staff of the firm, the importance of which cannot be overrated where the requirements of modern science are to be successfully carried out.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Royal Microscopical Society.

NOVEMBER 16TH, Rt. Hon. Sir Ford North, F.R.S., in the chair. Mr. Rousselet described two old microscopes which had been presented to the Society by Mr. C. L. Curties. The first was a copy by Dollond of Cuff's "New Constructed Double Microscope," designed by Cuff in 1744, in which the body was moved instead of the stage, the latter being customary in microscopes of later date. The second microscope was a copy of "Jones' most improved compound microscope," made and modified by Banks, between 1811 and 1820, though the invention of this type dates from 1798. Mr. Hugh C. Ross, R.N., exhibited and described a new electric warm stage of his invention. It consisted of a flat plate or box of ebonite about 3 inches long, 1½ inches wide, and ⅜ inch thick. A coil of wire offering a standard resistance was pressed into the ebonite box and covered in with a sheet of mica. The ebonite box rested on the slide, mica side downwards, and a gap 1 inch square was left in the centre of the stage so as not to interfere with the examination of the object. A Nernst lamp served both as illuminant and regulator of the current to the warm stage. It was claimed that this warm stage, being used above the slide, did not interfere with the focus, could be used with the highest powers, allowed the use of a condenser, did not interfere with the movement of the mechanical stage, and was self-acting. Mr. C. L. Curties exhibited new designs of Nernst lamps suitable for use with the microscope for currents of 100 and 200 volts respectively, and fitted with ground or blue glass fronts. Mr. Conrady read a paper on "Theories of Microscopic Vision. A vindication of the Abbe Theory," which contained some new views on the subject.

The Quekett Microscopical Club.

The 417th Ordinary Meeting of the Quekett Microscopical Club was held on November 18th at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. Mr. A. E. Smith exhibited a number of large transparencies, prepared from his own photo-micrographs. Notes by Mr. A. E. Merlin, F.R.M.S., "On a suggested modification of Rousselet's Live Box" and "A supplementary note on the foot of the House Fly" were, in the absence of the author, read by the Hon. Secretary. In the first note Mr. Merlin, after paying tribute to the manifold advantages of the Rousselet Live Box, alluded to the fact that the comparatively rapid evaporation of the water film prevented any prolonged observation of minute organisms such as monads, &c., under high powers. If, however, the cover-glass is cemented to the flange instead of being screwed in, and if a rubber band is slipped round the junction of the box and the carrier, a practically airtight joint is formed, and evaporation proceeds so slowly that he had been able to keep an object under observation for several days.

Mr. Merlin's second note was a continuation of two previous papers on the same subject read before the club in 1895 and 1897. He now reported that he had succeeded in detecting a small knob or protuberance on the side of the sickle-shaped terminal appendages of the hairs of the *pulvillus*, which knob, in his opinion, marked the position of the aperture through which the viscid secretion was poured out. He had not, however, been able as yet to detect the aperture with the highest optical power at his disposal, viz., ⅛" apochromat by Zeiss of N.A. 1.427 and a 40 compensating ocular. Even with this magnification the image of the sickle filament was sharp and clear.

Mr. A. E. Conrady, F.R.A.S., F.R.M.S., then gave a *résumé* of his important paper "Theories of Microscopical Vision—a Vindication of the Abbe Theory," which had been read before the Royal Microscopical Society on the previous Wednesday.

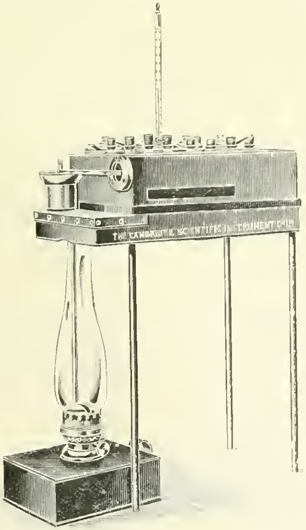
Micro-photographs.

The term micro-photograph is used in England to distinguish minute photographic reductions of larger objects in contradistinction to photographs of enlargements of microscopic objects which have been magnified by means of the microscope, and which are known as photo-micrographs. In the "Photographic Reference Book" for 1904 an account is given of the method of preparing such micro-photographs, of which the following brief *résumé* may be of interest. They require considerable patience and skill, as the image is so minute that the operations of development, &c., must be carried out in the field of a magnifier or small microscope. Most of these photographs are made abroad, and the collodion process (wet plate) is used, or collodio-albumen may be employed. The collodion used for making the plates must be structureless or the magnified images will have a reticulated appearance. Pyrogallic acid is preferable to iron sulphate for development, as it gives a much finer deposit. The process consists in making a positive by copying an illuminated negative, using a one-inch microscopical objective for this purpose. Mr. Hislop has devised a suitable apparatus, which is described in Mr. Sutton's "Dictionary of Photography." It consists of a rigid mahogany board about six inches wide and three feet six inches long. At one end two uprights are fixed, between which a miniature camera, fitted with the microscopical objective, can be moved up and down so as to allow it to be placed opposite the negative to be copied. A brass tube projects from the camera towards the negative, to carry the objective, and is fitted with stops of different sizes. The exact focus must be ascertained carefully by means of a strong magnifying glass. The negative is placed in a frame at the required distance on the long mahogany board. The illumination may be natural or artificial, but must, of course, pass through the negative, whilst the variations of light, negative, and pl te, render it impossible to give any idea of exposure. It will generally be found that the visual and actinic foci do not coincide, and this must be determined by experiment and allowed for, so that a fine adjustment becomes necessary. After exposure the little plate is placed under a low power microscope, in yellow light, and a few drops of developer poured over it, development being carefully watched through the microscope, remembering that a transparency is required, and, therefore, greater density than otherwise should be obtained. After fixing and drying, and before mounting, the tiny plates should be

examined through a lens of about the same power as they are intended to be viewed through, in order to see whether they are worth proceeding with. The photographs are then cut into small squares with a diamond, and can be mounted direct on to slides of the ordinary form or to the flat end of the small Stanhope lenses, to which they are generally attached. The slide or the Stanhope lens must be warmed, and the mounting medium is Canada balsam. Care must be taken that the contact is perfect, and that the slide is free from either air-bubbles or dust.

New Regulator for Cambridge Embedding-Bath.

The Cambridge Scientific Instrument Co. have brought out a new regulator for their well-known and most convenient embedding-bath, which does away with the former mercury regulator with its failings. The new regulator was primarily designed to utilize an ordinary paraffin lamp, where gas is not available. The hot air travelling up a short chimney heats the water in the bath. Suspended over the chimney by a lever is a plate of brass serving as a sort of lid. This lever is in contact with a bar of aluminium which is enclosed inside the bath, and is stayed between similar bars of nickel steel in such a way that it can only move laterally, and in so moving raise or depress the



lever according to variations in temperature of the bath. Any such movement of the lever therefore alters the position of the lid, and consequently regulates the amount of heat transmitted to the bath. Provision is made for the primary adjustments. Though originally arranged for a lamp (as illustrated) I think it would be equally effective with a small burner, and I believe the makers have adapted it accordingly.

I would like to call attention to the fact that the Cambridge Scientific Instrument Co. have just reduced the price of the improved 1900 model of their well-known Rocking Microtome to £3 15s., and have withdrawn the older model altogether. For cutting serial paraffin sections this microtome has now a European reputation, and needs no recommendation. It is in use in probably every large English laboratory, and the reduction in price should largely increase its use by all classes of workers.

Journal of the Quekett Club.

The half-yearly issue of the *Journal of Quekett Microscopical Club*, dated November last, contains the following papers :—"The Genital Organs of *Taenia sinuosa*," by Mr. T. B. Rosseter (illustrated); "Some New Sense Organs in Diptera," by Mr. W. Wesche (illustrated); the description of two new British Water-mites, by Mr. C. D. Soar, and a list of the Spiders of the *Erigone* group, by Mr. F. P. Smith. None of these papers lend themselves to review, but the Proceedings of the Club contain a *résumé* of an interesting lecture by Dr. E. J. Spitta on suiting screens for photo-micrography of stained bacteria in order to increase contrast, with reference to the value of the light for photographic rather than visual purposes. Dr. Spitta had tested by means of a spectroscope the behaviour of various orthochromatic plates to light of different wave-lengths, and his paper is illustrated by a plate showing the result, which deserves careful study by photo-micrographers.

Notes and Queries.

Mounting Volvox, Larvæ of Water Insects, &c.

Mr. F. T. Perks, of Denmark Hill, would be glad to know if there is any method of mounting Volvox, Larvæ, &c., so as to preserve their natural colour. The ordinary methods of mounting certainly fail to do this, and most zoologists would either examine the objects alive or stain them in such a way as to bring out some special feature. So far as the larvæ are concerned I think they might be narcotized by cocaine, then killed with a ¼ per cent. solution of osmic acid, and mounted in 2½ per cent. solution of formalin according to Mr. Rousselet's method for Rotifera, but I could not say whether this would prove practicable with Volvox, which is a particularly difficult object to mount satisfactorily so as to show all the structure. Full particulars of Mr. Rousselet's methods have been frequently published; there is a very full account in Cross and Cole's "Modern Microscopy." Perhaps Mr. Perks will let me know the result of his experiments, or I should be glad of suggestions from other readers.

Use of the Petrological Microscope.

Mr. J. F. K. Green wishes to know of a book dealing with the use of the petrological microscope. There is unfortunately no book dealing with the subject from the microscopic standpoint, even the largest works being strangely silent on the matter. In the "Annual of Microscopy" for 1900 I endeavoured to deal with the fundamental principles of the subject in an article entitled "The Practical Applications of the Polarizing Microscope," to which I may perhaps refer my correspondent if he requires a brief *résumé* of the subject. For further information he might read Groth's "Physikalische Krystallographie," or Dana's "Textbook of Mineralogy," or Rutley's "Study of Rocks," and Cole's "Practical Geology," which deal with the petrological and geological side, and incidentally touch on the microscopical methods. I must warn him, however, that the subject is one that requires study if it is to be of practical service in petrology or crystallography.

Echinus Spines.

Rev. W. Hamilton Gordon, Fareham.—Mr. Alfred Death, of Bury St. Edmunds, who kindly sent me the spines, informs me that they are *Echinus sphæra*, and that he found several of them on the coast at St. Osyth, a village between Clacton-on-Sea and Brightlingsea.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for January.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 8.8, and sets at 4.0; on the 31st he rises at 7.42, and sets at 4.45.

The earth is nearest the Sun on the 1st at 5 a.m., hence he attains his maximum apparent diameter of 32′ 35″.

Sunspots, faculæ, and prominences are very numerous; at the time of writing there are several fine groups of spots almost stretching from limb to limb, which define the spot zone most conspicuously.

For plotting the positions of spots, &c., the following table may be used:—

Date.	Axis inclined from N. point.	Equator N. of Centre of disc.
Jan 1 ..	2° 1′ E.	3° 13′
,, 11 ..	2° 52′ W.	4° 19′
,, 21 ..	7° 33′ W.	5° 17′
,, 31 ..	11 55′ W.	6° 4′

THE MOON:—

Date.	Phases.	H. M.
Jan. 5 ..	● New Moon	6 17 p m.
,, 13 ..	First Quarter	8 11 p.m.
,, 21 ..	Full Moon	7 14 a.m.
,, 28 ..	Last Quarter	0 20 a.m.

OCCULTATIONS.—The following occultations of the brighter stars are visible at Greenwich.

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
Jan [illegible]	[illegible] Aquarii	[illegible]	5.9	45	31	6.23	265	240
,, [illegible]	B.A.C. [illegible]	[illegible]	9.40	37	28	10.36	306	284
18	[illegible] Tauri	[illegible]	5.58	103	142	7.1	240	276
19	26 Geminorum	[illegible]	3.51	130	180	5.24	213	254
			a.m.			a.m.		
24	β Virginis	[illegible]	0.45	145	174	1.40	260	281

THE PLANETS:—Mercury.—Towards the end of the month Mercury is a morning star in Sagittarius, being at greatest elongation of 24 28′ W. on the 22nd, when he rises at 6.24 a.m.

Venus is the most conspicuous object in the evening sky looking towards the S.W., and sets about 4 hours after the sun. The planet is increasing in brilliancy, and can readily be seen when on the meridian in broad daylight; the time of meridian passage is 3.5 p.m. and is very nearly the same on each day of the month, whilst the meridian altitude increases from 23 on the 1st to 37½ on the 31st. The apparent diameter of the planet on the 15th is 15″·2; the disc appears slightly gibbous, 0·65 being illuminated.

Mars does not rise until after midnight.

Jupiter is on the meridian shortly after sunset, and remains above the horizon until midnight. In consequence of increasing distance from the earth, the planet is diminishing in lustre: the apparent equatorial diameter is 40″·5 on the 16th, whilst the polar diameter is 2″·6 smaller. The planet is in quadrature on the 12th.

The following table gives the phenomena of the satellites visible in this country.

Date.	Satellite.	Phenomenon.	P.M.'s H.	M.	Date.	Satellite.	Phenomenon.	P.M.'s H.	M.	Date.	Satellite.	Phenomenon.	P.M.'s H.	M.
2	II.	Ec. R.	6	13	13	I.	Oc. D.	7	1	22	I.	Ec. R.	6	57
4	I.	Oc. D.	10	37		III.	Tr I.	8	52	23	II.	Oc. D.	8	57
5	I.	Tr. I.	7	45		I.	Ec. R.	10	32	24	III.	Ec. D.	8	41
	I.	Sh. I.	9	6		III.	Tr. E.	11	6		III.	Ec. R.	10	12
	I.	Tr. E.	9	59	14	I.	Sh. I.	5	31	25	II.	Tr. E.	6	41
	I.	Sh. E.	11	18		I.	Tr. E.	6	23		II.	Sh. I.	6	49
6	I.	Oc. D.	5	5		I.	Sh. E.	7	43		II.	Sh. E.	9	18
	III.	Tr. E.	7	5	16	II.	Oc. D.	6	18	28	I.	Tr. I.	8	3
	I.	Ec. R.	8	37		II.	Oc. R.	8	50		I.	Sh. I.	9	22
	III.	Sh. I.	10	29		II.	Ec. D.	9	3		I.	Tr. E.	10	17
7	I.	Sh. E.	5	47	17	III.	Ec. R.	6	11	29	I.	Ec. R.	8	53
	II.	Tr. I.	9	29	18	II.	Sh. E.	6	40	30	I.	Sh. E.	6	3
9	II.	Oc R.	6	13	20	I.	Oc. D.	8	57	31	III.	Oc. D.	7	8
	II.	Ec. D.	6	26	21	I.	Tr. I.	6	6		III.	Oc. R.	9	24
	II.	Ec. R.	8	50		I.	Sh. I.	7	26					
12	I.	Tr. I.	9	40		I.	Tr. E.	8	19					
	I.	Sh. I.	11	2		I.	Sh. E.	9	39					

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is diminishing in brightness, and is only observable for a short time in the S.W. after sunset. The plane of the ring is inclined to our line of vision at an angle of 14 ; hence the ring appears well open.

Uranus is unobservable.

Neptune souths at 11.45 p.m. on the 1st and at 9.44 on the 31st. He is situated in the constellation Gemini and can readily be found by reference to μ Geminorum.

	Right Ascension.	N. Declination.
Neptune (Jan 14) .	$6^h\ 27^m\ 19^s$ ..	22° 16′ 33″
μ Geminorum . .	$6^h\ 17^m\ 13^s$ ..	22° 33′ 36″

METEOR SHOWERS:

Jan. 2-3	XV.h 20m	+ 53	Quadrantids	Swift; long paths.
,, 17	XIX.h 4m	+ 53	θ Cygnids	Slow; bright.

THE STARS:

Minima of Algol occur between sunset and midnight on the 13th at 10.37 p.m., 16th at 7.26 p.m., and 19th at 4.14 p.m.

o Ceti (Mira) should be watched, as it will probably reach a maximum next month, when observation will be difficult on account of daylight.

TELESCOPIC OBJECTS:—

Nebulæ.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

Crab Nebula (M 1), in Taurus, situated about 1½° north-west of ζ Tauri in R.A. 5h. 29m., Dec. 21° 58′ N.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact; its position is R.A. 5h. 46m., Dec. 32° 32′ N.

DOUBLE STARS.—β Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

δ Orionis, mags. 2 and 7, separation 53″; easy double.

ζ Orionis, triple, mags. 3, 6, and 10, separation 2″·5 and 56″; rather difficult in a 3-inch telescope.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42.″

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

VOL. II. No. 2. [NEW SERIES.] FEBRUARY, 1905. [Entered at Stationers' Hall.] SIXPENCE.

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Editorial.

At the end of the first year of the New Series of "KNOWLEDGE," it will not, perhaps, appear supererogatory to review the progress of the journal since its amalgamation with the "ILLUSTRATED SCIENTIFIC NEWS," from a material as well as from an editorial standpoint. It was intended in the amalgamation to preserve and present the features of both periodicals; that is to say, while the editors were determined that there should be no falling off either in the amount or the value of those contributions to Astronomic and Natural Science which had, up to that time, formed the chief contents of "KNOWLEDGE," they also believed that it was desirable to effect a general re-arrangement of the periodical, and to add to it articles on Physics, Chemistry, and Applied Science. The reason for this belief was not alone that they thought themselves bound to such a programme out of consideration for the large number of readers of the "ILLUSTRATED SCIENTIFIC NEWS" who had become subscribers to the amalgamated periodical; but because they were convinced that in the new significance and importance which applied science is now recognised as having in every department of the national life, there was a real demand for an organ which should deal with such subjects in a manner that was at once authoritative, comprehensible, and interesting. No pains or expense were therefore spared to attain this end, and it is an ideal to which the conductors of the paper will steadily adhere during the coming year. The difficulties that have presented themselves are none the less considerable. In the first place there has been the question of preserving the former scientific interests of the paper without diminution, while adding the new subjects. That has been a matter which has involved considerable additional expense, because it has necessitated not only the payment for special articles, but the enlargement of the paper by the double method of increasing the number of its pages and of adding to the quantity of contributed matter by the reduction, on several pages, of the type. We believe that in spite of one or two complaints that this or that subject has been included which an isolated reader did not want, the endeavour has completely succeeded, and that we have added alike to the attractiveness and value of "KNOWLEDGE." The feature of attractiveness has also involved better printing, a very large increase in the number and variety of illustrations, and a better quality of paper. These matters have been among the additional sources of expense, and in order that the standard which has been set up may be maintained, we desire to make a special appeal to readers of "KNOWLEDGE AND THE SCIENTIFIC NEWS" to give us an increasing support. There is no other scientific periodical in the United Kingdom which occupies the same or even a similar position, and in making this appeal we feel that we are doing so not only on behalf of the commercial success of our venture, but on behalf of the popular advancement of scientific teaching and information.

Some of the commercial difficulties that we have encountered in an anxious year have made it necessary to effect a re-arrangement of the editorial staff, but during the coming year the journal will be conducted by the same editors as heretofore, with the exception that Mr. E. Walter Maunder, F.R.A.S., in whose hands the Astronomical editorship of "KNOWLEDGE" has been so long, and whose services to the paper have been most valuable, will, we regret to say, no longer be able to continue in that position. We hope, nevertheless, that his name will continue to appear as a contributor to the paper. Steps are being taken to place the astronomical editorship in responsible hands, and articles on astronomical subjects will continue to appear from Miss Agnes Clerke, Dr. W. J. S. Lockyer, Mr. J. E. Gore, and Mr. Shackleton.

In addition to some fine astronomical photographs which we hope to present as full-page supplements, we are having prepared some star maps on a new and original system, which, when collected, should form a complete atlas of the heavens.

It is proposed to continue the articles on Physics, Chemistry, and Geology, which have been a feature of the later numbers, and we have been promised a continuance of contributions by Prof. A. W. Porter, Dr. F. Mollwo Perkin, Prof. Grenville Cole, and Mr. H. J. H. Fenton. Natural History will again be expounded by such authorities as Dr. Sclater, Mr. Lydekker, Mr. P. Collins, and others. In all other respects "KNOWLEDGE" will be conducted on those lines which in the past year we hope have proved to be acceptable to the great majority of our readers.

Modern Cosmogonies.

XII.—Our Own System.

By Miss Agnes M. Clerke.

Our sun is clearly middle-aged. It bears none of the marks associated with juvenility in stars; and its decrepitude is in the distant future. It is crossing, probably, a level tract where recuperation so nearly balances expenditure that radiation can be maintained for an indefinite time at a high and fairly uniform standard. Stars of the solar type pursue the even tenour of their way with particularly few interruptions. They show little tendency to intrinsic variability. Their periodicity, when it exists, is due to the presence of a companion. Light-changes can thus be impressed upon them by external influence; they do not conspicuously arise through native instability.

Our planet, accordingly, is attached to a safe and steady luminary; one subject, not to destructive spasms, but to vicissitudes so mild as to evade distinct meteorological recognition. It is, moreover, governed by a polity settled on a broad basis of tranquillity and permanence. All this is as it should be. The conditions specified were a pre-requisite to the unfolding of human destinies. Nor can it be confidently asserted that they have been realised anywhere else. Our system may be unique; while, on the other hand, replicas of it might, imperceptibly to us, be profusely scattered through the wide realms of space. It is certain that a telescopic observer on Sirius or α Centauri would see our sun unattended; not even Jupiter could be brought into view by optical appliances in any degree comparable to those at our disposal. There are, nevertheless, strict limitations to the possible diffusion of planetary worlds like those that wander amid the zodiacal constellations. We have become aware of incapacitating circumstances, by which a multitude of stars are precluded from maintaining retinues of subordinate globes. Spectroscopic discoveries have compelled a revision of ideas as to cosmical arrangements. Especially the large proportion established by them of binary to single stars makes it impossible any longer to regard the solar system as a pattern copied at large throughout the sidereal domain. We cannot, then, compare it with any other; the mechanism of which the earth forms part must, perforce, be studied in itself, and by itself; and it may, for aught that appears, be the outcome of special and peculiar design.

The machine in question is self-sustaining and self-regulating; no extraneous influence noticeably affects its working. This exemption from disturbance is the fortunate consequence of its isolation. A great void surrounds it. The span of Neptune's orbit is but a hand-breadth compared with the tremendous unoccupied gulf outside—unoccupied, that is to say, by bodies of substantial mass. The feebleness of star-light relatively to sun-light affords some kind of measure of the impotence of stellar attractions to compete with the over-ruling gravitational power that sways the planetary circulation. This it is which gives to it such remarkable stability. The incomparable superiority of the sun over his dependant orbs not only safeguards them against foreign interference, but reduces to insignificance their mutual perturbations. Hence, the strong concentration of force exemplified in our system—the absolutely despotic nature of the authority exercised—makes for a settled order by excluding subversive change.

The organisation of the solar kingdom, as disclosed by modern research, is greatly more varied and complex than Laplace took it to be. His genetic scheme was, indeed, no sooner promulgated than deviations from the regularity and unanimity of movement upon which it was based began to assert their inconvenient reality. They have since multiplied; and, emerging to notice under the most unlikely aspects, they occasion incongruities which tax, for their explanation, all the resources and audacities of the most inventive cosmogonists. Let us briefly consider their nature.

The swarm of asteroids that bridge the gap between Mars and Jupiter revolve, it is true, with the general swirl of planetary movement; but use a large licence as regards the shape and lie of their orbits, and their partial exemption from the rules of the road becomes entire for comets and meteors, which have proved themselves, nevertheless, to be aboriginal in our system by their full participation in its proper motion. Finally, several of the major planets set convention at defiance in the arrangement of their several households, and thereby intimate departures from the supposed normal course of development so frequent and so considerable as to shake belief even in its qualified prevalence. Thus, the anomalously short period of Phobos, the inner satellite of Mars, besides throwing doubt over its own mode of origin, tends to obscure the history of its more sedately circulating associate. The sub-systems of Uranus and Neptune exhibit, moreover, eddies of retrograde movement, suggesting primitive disturbances of a fundamental kind; while the surprising disclosures connected with Saturn's first-born, and furthest satellite, have added one more knotted thread to the tangled skein we would fain unravel. Until acquaintance was made with Phœbe, counter-flows of revolution within the same satellite-family were unknown, and, if contemplated at all, would have been scouted as impossible. One ternary star, to be sure—ξ Scorpii—had been recognised as probably owning an immediate and a more remote attendant, in oppositely directed orbital movement; but the cases are in many ways disparate, and the analogy, though instructive, is imperfect.

If the ninth Saturnian moon is to be regarded as sprung from the mass of its primary, a total change in the condition of the parent body must have supervened during the long interval between its separation and that of its successor Iapetus. The change, in Professor W. H. Pickering's opinion,* was nothing less than a reversal in the sense of axial rotation. The nebulous spheroid destined to develop into the wonderful Saturnian system had a diameter, when Phœbe was thrown off from it, of sixteen million miles, and gyrated tranquilly from east to west, in a period of about a year and a half. The action of sun-raised tides, however, availed first to destroy, and finally to invert this movement; for the natural outcome of tidal friction is synchronism, and this implies agreement, both in period and direction, between the rotation and revolution of the body acted upon. Acceleration through contraction did the rest; and before Iapetus entered on its separate career, the originating globe span normally in seventy-nine days. The view that such was the course of events is plausible at first sight;

* *Harvard Annals*, Vol. LIII., p. 61, where, however, the reversal is explained by a shifting of the axis of rotation. The mode of action described in the text was long ago suggested by Kirkwood.

yet the doubt remains whether the cause alleged was adequate to the effect produced. At the distance of Saturn, solar tidal friction exerts only about one-twenty-thousandth its power on the earth*; its efficacy would, it is true, be greatly enhanced by the distension of the mass subjected to it; but approximately to what extent, it baffles our powers of calculation to determine.

The one certain inference derivable from the diversity of facts ascertained within the last hundred years is that our world is not (so to speak) machine-made. The *modus operandi* employed to disengage the planets from their nebulous matrix was not of cast-iron rigidity; it was adaptable to circumstances; it left room for the display of boundless inventiveness in details. This, nevertheless, was made to consist with the perfect preservation of the main order, both in design and operation. The general plan is broadly laid down and unmistakable, and the springs of the machine are undisturbed in their free play. And for the primary reason that departures from regularity, which might in any way, prove a menace to stability, affect bodies of negligible mass. The great swing of settled movement goes on irrespectively of them. *De minimis non curat lex.* Thus, the erratic behaviour of comets is harmless only because of their insignificance. If pursued by substantially attractive masses, it could not fail to jeopardise the planetary adjustments. Even the asteroids would be unsafe neighbours but for their impotence; and it is remarkable that Mercury, by far the smallest of the major planets, circulates along a track of the asteroidal type. It would seem as if an important size carried with it an obligation to revolve in an orbit of small eccentricity, inclined at a low angle to the principal plane of the system. The reason why this should be so is not obvious; but were it otherwise, the equilibrium, now so firmly established, would subsist precariously, or not at all.

The assertion, indeed, that it is firmly established, can only be made under reserve. We are ignorant of any causes tending towards its overthrow; yet they may supervene, or be already subtly active. One such lurking possibility is the presence of a resisting medium in interplanetary space. Waifs and strays of matter must, at any rate, be encountered there—outlawed molecules, self-expelled from the gaseous envelopes of feeble globes; thin remnants of cometary paraphernalia, driven off amid the fugitive splendours of perihelion; products of ionic dissociation set flying by the impact of ultra-violet light—and all disseminated through an ethereal ocean, which "is cut away before, and closes from behind," as moving bodies traverse it. That its indifference is shared by ordinary material substances, when in the last stage of attenuation, is a plausible but unverified conjecture. It is only safe to say that retardation of velocity in what may pass for empty space is insensible, or null.

There may, nevertheless, be springs of decadence in the solar system. Some of them have been discussed by M. Poincaré,† whose confidence in the reassuring demonstrations of Laplace and Lagrange is inversely proportional to the magnitude of the terms they were forced to neglect. They dealt with fictitious globes, devoid of appreciable dimensions, and swayed by the strict Newtonian law. But the real planets and their satellites are acted on by other forces as well, frictional, magnetic, radio-repulsive; and their joint effects may not be wholly evanescent. The tidal drag on rotation undoubtedly occasions a small but irretrievable loss of energy. The moon, for instance, as M. Poincaré states, now gains, by the reactive consequences of tidal friction in widening its orbit, no more than [illegible] the *vis viva* of which the earth is deprived by the infinitesimal slowing down of its rotation. And the remaining [illegible]ths, being dissipated abroad as heat, are finally abstracted from the system. The ultimate state, we are told, towards which the planetary mechanism tends, is that of the synchronous revolution, in a period of about twelve years, of all its members. This might, apart from a possibly resisting medium, have indefinite permanence; otherwise precipitation to the centre would gradually ensue, and one solitary sphere, cold, stark, and unilluminated, would replace the radiant orb of our cerulean skies, with its diversified and exquisitely poised *cortège*. Unsecured drafts upon futurity, however, are not among the most valuable assets of science; and a consummation so incalculably remote may be anticipated by a score of unforeseen contingencies. What can be, and has been ascertained, is the relative durability of the scheme with which the visible destinies of the human race are so closely connected. It will, beyond question, last long enough for their accomplishment. Curiosity that would seek to penetrate further is likely to remain ungratified.

But this is not all. There are other, and incalculable items in the account. The sun, although an autocrat within his own dominion, is himself subject to external influences. As a star, he is compelled to follow whithersoever the combined attractions of his fellow-stars draw him; nor can we thoroughly interpret the summons which he obeys. The immediate outcome in the transport of the solar system towards the constellation Lyra, has, it is true, been determined; but the eventual scope and purpose of the journey remain profoundly obscure. The pace is to be reckoned as leisurely; twelve miles a second is little more than half the average stellar speed. We should, however, probably suffer no inconvenience from being whirled through the ether in the train of such a stellar thunderbolt as Arcturus. Only the excessive velocities of any adventitious bodies we might happen to pick up would betray to ordinary experience the fact of our own swift progress. As it is, our sweepings from space appear to be scanty. If shreds from inchoate worlds, or dust of crumbled worlds, strewed the path of our system, they should be annexed by it in its passage, temporarily or completely; and we should then expect to find the apex of the sun's way marked, if no otherwise, by the predominant inflow from that quarter of comets and meteors. Yet there is no trace of such a preference in the distribution of their orbits. Hence the enforced conclusion that the sun has attached to him, besides the members of his immediate household, an indefinite crowd of distant retainers, which, by their attendance upon his march, claim with him original corporate unity. To this rule there may be a few exceptions. An occasional aërolite probably enters the earth's atmosphere with hyperbolic velocity, and takes rank accordingly as, in the strictest sense, a foreign intruder; but the broad truth can scarcely be challenged that the sun travels through a virtual void.

We can, however, see no necessity why he should for ever continue to do so. Widely different conditions seem to prevail near the centre, and out towards the circumference of the sidereal world. What may be designated the interior vacuity of the Milky Way is occupied mainly by stars of the solar type, including

* G. H. Darwin, *Phil. Trans.* Vol. CLXXII., p. 526; Moulton, *Astroph. Jour.*, Vol. XI., p. 110.

† *Annuaire du Bureau des Longitudes*, 1898.

one to our apprehension super-eminent over the rest; they are separated by vast, apparently clear intervals; they are non-nebulous, and of stable constitution. This secure habitat is ours for the present; it may, nevertheless, at some future time be exchanged for one less exempt from disturbance. The shape and size of the sun's orbit are utterly unknown ; the changes of environment, accordingly, that will accompany the description of it defy conjecture. Our actual course is inclined at a small angle to the plane of the Milky Way. It will presumably become deflected; but perhaps not sufficiently to keep our system clear of entanglement with the galactic star-throngs. In our ignorance of their composition, no forecast of the results can be attempted; they are uncertain and exorbitantly remote. Moreover, the comparative slowness of the sun's motion in a manner guarantees the permanence of his subsisting cosmical relations. For anything that science can tell, they may ultimately be subverted by some preordained catastrophe; but the possibility lies outside the field of legitimate speculation.

The universe, as reflected in the mind of man, gains extent as the mirror acquires polish. Early astronomers conceived of but one solar system, and one "dædal earth," upon which the "pale populace of heaven" rained influences sinister or propitious. Later, human egotism took another form. The whole universe was assimilated to our particular little settlement in it. Terrestrial conditions were universalised. None divergent from them were counted admissible or profitable. But one answer seemed possible to the perpetual *Cui bono*? with which restless thought assailed the heavens. But one purpose was regarded as worthy of fulfilment; that of multiplying, in distant sidereal climes, copies of our own planet, and of providing suitable locations for myriads of intellectual beings, as little alien to ourselves as might be compatible with the minimum of diversity in their material surroundings.

The spread of this astral philanthropy has, nevertheless, been in some measure checked by the advance of knowledge. Our position and circumstances have been shown by it to be, if not quite peculiar, at any rate very far from inevitable. It has reduced by a process of exclusions to a relatively limited number the class of stars that can fairly be regarded as possible centres of vitality; it has immensely widened the scope of discernible variety in cosmical arrangements, and held out warnings against errors of interpretation due to congenital prepossessions. And we shall surely not wander from the truth by recognising our inability to penetrate all the depths and intricacies of Infinite Design.

To Prevent the Stripping of Photographic Films.

In warm climates it is often most difficult to prevent the gelatine film from becoming detached from a plate during development, and the usual methods, such as adding a little alcohol to the developer are not sufficient. Other methods are objectionable on account of their effect on the development or fixing. M. Mercier has lately tried, with good effects, tannin the gelatine. A bath is made up of the following:—Alcohol (90°) 250 cc, tannin 60 gr., water 500 cc. The plates are immersed for two or three minutes in this bath, after which they are carefully washed before being placed in the developer. The final washing must be continued until all traces of tannin have disappeared.

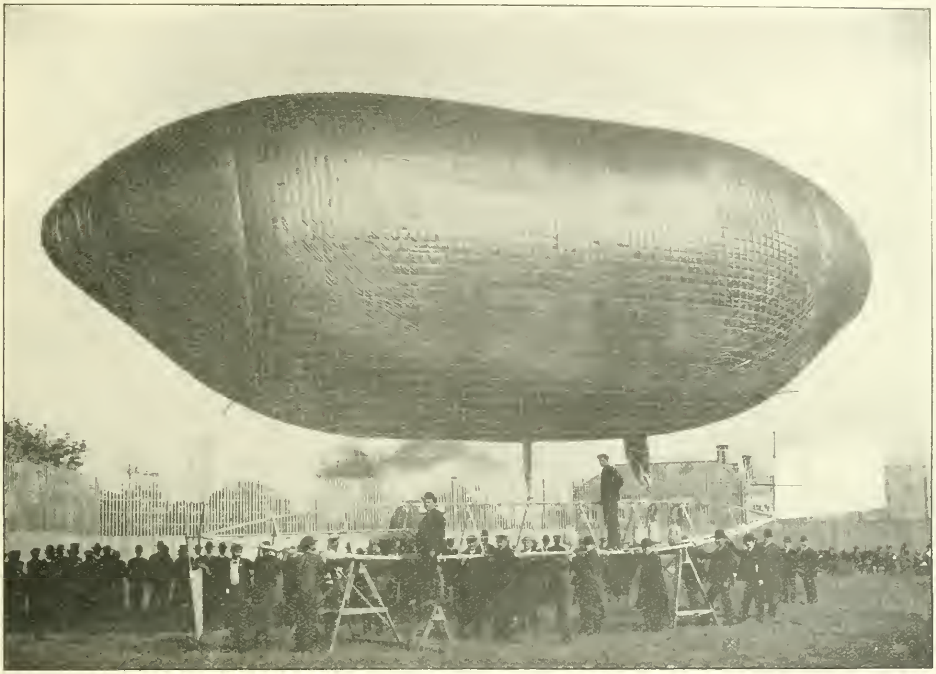
Progress with Airships in 1904.

By Major B. Baden-Powell.

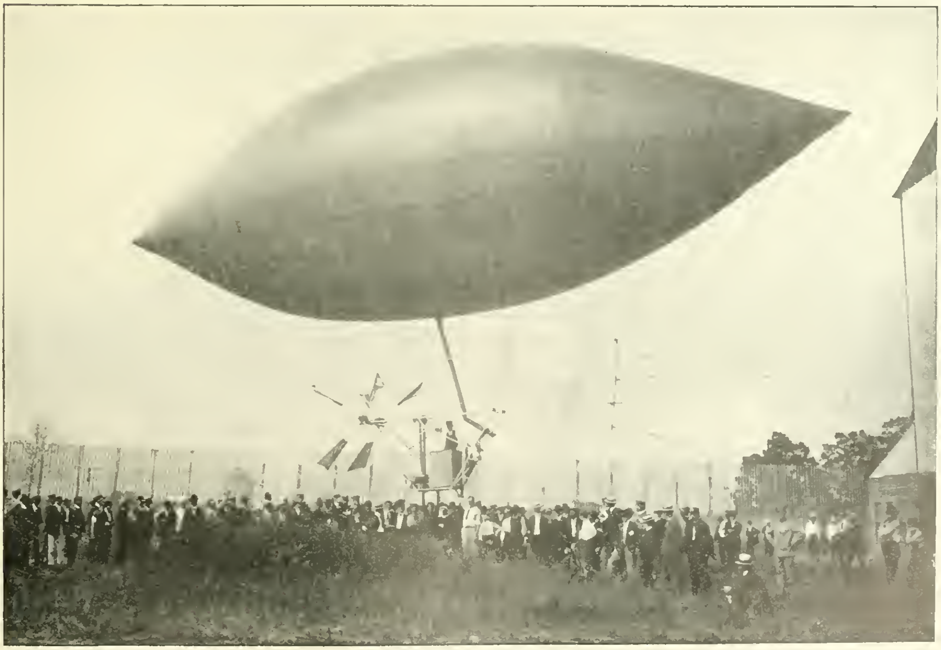
Notwithstanding the very tempting bait of a prize of £20,000 for an airship capable of attaining certain speeds over a fixed course, the competition in connection with the World's Fair at St. Louis can hardly be characterized as a success. Not only was there a lack of machines specially built with the object of carrying off this prize, but there was even a noticeable absence of those in existence which might have been able to comply with the conditions. M. Santos Dumont, for some reason not yet clearly explained, withdrew after taking his powerful new airship across the Atlantic. MM. Lebaudy do not seem to have had any intention of submitting for trial their most successful machine, nor did M. Deutsch send over more than a model of his "Ville de Paris." But what is even more unaccountable is that American inventors, such as the Messrs. Wright and Prof. Langley, were conspicuous by their absence, and did not enter their flying machines even for show. The rumours we have heard of Mr. J. P. Holland, of submarine-boat fame, and Prof. Graham Bell, the inventor of the telephone, having respectively devised new apparatus to navigate the air, have received no corroboration from St. Louis.

However, it cannot be said that there were no airships at the Fair. Three of them were open to inspection in the huge sheds specially constructed for housing the competing vessels. Two of them actually made ascents, and with some success. Unfortunately, the most promising of the three, that of M. Francois, could not even be inflated with gas. This apparatus consists of an elongated balloon of 1,150 cubic metres, supporting a wooden car containing a 25-28 h.p. Lambert water-cooled petrol engine (weighing 270 lbs.), which rotates two pairs of screw propellers. There are two horizontal shafts, one on each side of the car. Each of these has a propeller mounted on each end of it. The fore screws (about 9 ft. diameter) are smaller than those in rear (12 ft.), the idea being that the larger after screw will be able to effect a bigger column of air without, presumably, having so much work to do as if the smaller screw had not already acted on an inner column of air. The reasoning of this may not seem to be quite sound, but practical trials alone could prove if there was anything in it, and we can but watch for results.

Mr. Baldwin, whose name was much before the English public some 15 years ago on account of his bold and sensational parachute descents, exhibited an apparatus of the Santos Dumont type. As may be seen from the photograph, the elongated balloon supported a long trussed-girder beam, towards the fore-end of which was a two-cylinder petrol engine of 5 h.p. (almost hidden, in the photograph, by the figure of Mr. Baldwin). A tractor screw was placed at the fore-end. This was 10 ft. in diameter, the blades being each 3 ft. 4 ins. long by 2 ft. 2 ins. wide. A large rudder was placed behind, moved by tiller lines. This machine made its first ascent on October 25, piloted by Mr. Knabenschue. There was a light wind blowing, about six to eight miles per hour, but this proved altogether too strong for the airship, which made several turns around, but failed to stem the breeze, and was carried away over the town of St. Louis. Some days after-



Baldwin's Airship.



Benbow's Airship.

The Lebaudy, 1904.

wards, however, during a calm, a more successful voyage was made, and the vessel, after taking a tour above the Fair grounds, returned successfully to its point of departure.

The third machine was that of Mr. Benbow. This was a beautifully-shaped balloon of 73 ft. long by 20 ft. greatest diameter, with pointed ends, beneath which was suspended a car-frame of angle-steel carrying a pair of feathering paddle-wheel propellers. A 4-cylinder engine developing 10 h.p. rotated these wheels, which were so constructed that normally the blades were opened while passing the lower portion of their path and closed while going over the upper half of the circle. But by an ingenious arrangement of cams this action could be altered, so that instead of driving forward, it was possible to cause the propellers to give an upward thrust, or even to reverse and give a downward or backward thrust. This arrangement may be good in theory, but it was palpable that much power was lost in the gearing and complication necessary. This apparatus was tried on several days in almost dead calms, but owing to insufficiency of lift it ascended to no great height. It was, however, well able to exhibit its powers, and the exact rate of progress could be measured. The fans revolved at exactly one revolution per second, and the airship progressed at a rate of just about three miles an hour, this being, of course, altogether insufficient for a practicable airship.

But while these more or less abortive attempts to further progress with airships were being carried on in America, some really important work was developing on this side of the Atlantic. France, the birthplace of the balloon and the country in which nearly all the more notable advances in aërial navigation have taken place, now contains what may undoubtedly be called the first really practicable airship.

It will be remembered how, in November, 1903, the Lebaudy airship, which had had so wonderfully successful a career, came to grief, while landing at Meudon.

The Lebaudy from Underneath.

(This apparatus was fully described in the *Illustrated Scientific News* of September, 1903.) The vessel was completely wrecked, but M. Julliot, backed by the affluence of MM. Paul and Pierre Lebaudy, at once started on the construction of a new machine. This has now been completed, and has undergone its trials with much success. The new machine is practically of the same design as the old one; indeed, most parts of it are the same, repaired. The gas-vessel is new,

having a somewhat different shaped stern and containing a rather larger volume of gas, namely, 2,600 cubic metres (94,000 c. feet). It is 58 metres long over all; the greatest diameter, 9 m. 80, being 24 m. 90 from the bow. The length is therefore about 5.6 times the maximum diameter. The surface of the balloon is about 1,300 square metres, and the weight of the envelope is 550 kilos. The material consists of four layers, one of cotton-cloth with a layer of caoutchouc, one-tenth of a millimetre thick, then another of cloth, and finally one of caoutchouc on the inside.

The former balloon had only two layers of cloth with caoutchouc between, but it is hoped that this extra layer will preserve the cotton from impurities in the gas. The balloon is also varnished with seven coats of a solution of caoutchouc in benzine, vulcanised with sulphur, and is painted yellow outside, so as to prevent the actinic light affecting the caoutchouc. So gas-tight is this material that 48 hours after its inflation there was no appreciable loss of gas.

The ballonnet, which can be filled with air as desired so as to keep the balloon taut, is of 500 c. metres. The ventilating-fan for this purpose is driven by the motor, but, when the latter is not working, may be driven by a small dynamo and accumulator.

In addition to the "manœuvring-valve" at the top of the balloon, there are some safety valves automatically opening under a pressure of 35 millimetres.

The lower portion of the balloon is flat, and is rigidly stretched on a horizontal oval framwork of steel-tubing; below this is a long vertical "keel" of steel tubing, covered with canvas, and at the after end of this is pivoted the rudder.

This horizontal plane and vertical keel impart great stability to the vessel while running.

One of the most notable features of the 1904 model is a large horizontal double-rudder or fin, placed at the stern of the balloon. This to modify or prevent any tendency to pitch. There are also two small horizontal rudders at the rear of the keel-frame, just in front of the vertical rudder.

The car, as before, is suspended from the oval steel frame by wire ropes, the thurst of the propellers being conveyed to the main vessel by a system of rigid steel tubes leading from the front of the car to the front of the oval frame.

The propelling mechanism is the same as in last year's machine. A 4-cylinder Daimler motor of 40 horsepower, running at speeds from 250 to 1,200 revolutions per minute, rotates the two screw propellers, one on each side of the car. These screws are 2 metres 44 in diameter and rotate 800 to 1,000 times a minute.

The first voyage of the new airship took place on the 4th of August. This, however, only lasted some twelve minutes, being but a trial trip to test the engines and steering arrangements. Everything proved highly satisfactory, and a few days later a second journey was undertaken. The wind on this occasion was blowing 13 miles an hour, yet the vessel rose and manœuvred around for a quarter of an hour at a height of 60 to 80 metres above the ground.

Several other short trips were successfully made on succeeding days, and on the 16th of August a longer journey was undertaken. This lasted 41 minutes, during which time the balloon covered a distance of about 26 kilometres (16 miles). On the 28th of August another ascent was made, and after 20 minutes of circling above the grounds, the airship descended and the aëronauts got out. Just then a strong gust of wind caught the balloon, the tethering ropes both snapped, and the balloon rose and floated away without any occupant! Instead of rising, as might have been expected, to a considerable height and being carried off to a great distance, the balloon seems to have kept low and to have several times actually touched the earth. Eventually it got caught up in a wood, 70 kilometres from its point of departure, and was deflated and taken back to its shed, having suffered but little damage.

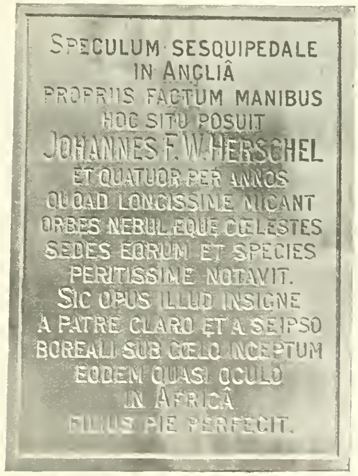
A number of other voyages were made later on, including one on the 22nd of November, which lasted for 1 hour and 33 minutes.

On the 22nd of December, the last voyage of the year was made, this being the thirtieth during 1904, and the sixty-third trial of this type of airship. All these trips were conducted by M. Juchmès, the aëronaut, who was usually accompanied by a mechanician and an assistant, and on several occasions a passenger was also carried.

To have accomplished all these journeys in varying weather, and, with one exception, each time to have safely returned to its shed, seems to prove that in this airship we really have at last a machine capable of navigating the air, and the promoters would appear quite justified in alluding to it, as they do, as the "aërial cruiser."

The Herschel Memorial

MR. J. P. MACLEAR writes from Beaconscroft, Chiddingfold, Godalming: "I was doubtful about the inscription I sent you for the north side of the Herschel Obelisk at Claremont, Cape of Good Hope. I now send an exact copy."



Bronze Tablet (about 11 × 15 inches) of a Latin Inscription for the Herschel Obelisk at Feldhausen, Cape of Good Hope.

W. J. Herschel, Scripsit, May-July, 1904. *Photo. by A. S. Herschel, Sept., 1904.*

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Dr. Russell's Experiments.—Last month I referred to the production of the developable condition by emanations from various substances as in Dr. Russell's experiments, and showed that although some results appear to indicate that the effect is due to a gas, and that this gas is the vapour of hydrogen peroxide, others are generally allowed to be difficult to account for on this simple hypothesis.

Professor J. Joly, in a letter to *Nature* last August, asks with regard to Dr. Russell's experiments and his suggestion that peroxide of hydrogen is the active agent, "ought we not rather to seek the explanation in the ionising properties of metals indicated by other observations?" He founds this question on his observation that pure mercury and polished speculum metal in contact with a rapid plate under absolute alcohol in an airtight desiccator over calcium chloride produced the developable condition in a gelatino-bromide plate just as vigorously as if it were obtained in ordinary moist air. It is, perhaps, worth while to sum up the recorded experiences of Dr. Russell with regard to conditions similar to those described by Professor Joly.

As to mercury, Dr. Russell found that, if pure, it was inactive, and that an active sample might be made inactive by purification, and that if pure and inactive the addition to it of one-thirty-thousandth of its weight of zinc rendered it very active.

As to moisture, Dr. Russell at first found no difference whether the action took place in air saturated with moisture or air dried with sulphuric acid or calcium chloride, or in an atmosphere of hydrogen. Later on, when he had found how intimately hydrogen peroxide was connected with the results obtained, he remarks that a gelatine plate is never really dry. He seems to have repeated the experiment of trying the different effects of an atmosphere dried by calcium chloride and an atmosphere kept moist, and found that after three days "the damp plate had much the darker picture on it." By passing dry air over zinc nothing was given off that affected a plate, but when moist air was passed over the metal and then allowed to impinge on the plate, the change was effected. He found also that dry alcohol neither transmitted the action nor was made active by putting zinc in it, but by adding the merest trace of water to the alcohol, the zinc did make it active.

Messrs. Blaas and Czermak (Science Abstracts, Section A, No. 2559, 1904) record the old and well-known fact that many substances after exposure to light are able to affect a photographic plate, or affect it more readily than they did before insolation. They say that this property is connected with the occlusion of ozone and that bright or amalgamated zinc possesses the property, and that many substances emit a diffuse radiation which is reflected at mirror-like surfaces. Dr. Russell states that he found ozone to be without effect, and in a communication to the Royal Society last June dealt with the effect of exposure to sunlight in rendering "active" substances more active. He says that "bodies other than those which may contain resin or allied substances are not affected in this way by light." "Metals are not rendered active by sunlight."

Dr. Luppo-Cramer finds that while a gelatino-bromide plate is affected by hydrogen peroxide, a collodio-bromide plate is not, and hence considers that the gelatine has a vital influence on the result. But his experiments are not strictly comparable with Dr. Russell's, as he immersed his plates in weak solutions of the peroxide, though he considers that this is the same in effect as exposing them to its vapour. I believe it has been observed that films apart from the glass support are not affected by these emanations. Thus it would appear that the glass, which is not permeable by them, is necessary to prevent them passing through the gelatine film and escaping with the production of little or no effect on the sensitive salt.

There are many other observations that bear upon this subject in a more or less direct manner, but I think that I have set down sufficient to show that there remains a considerable measure of uncertainty with regard to some of the observations, and that it is impossible to rest satisfied with the suggestion that the effects are the simple results of the action of peroxide of hydrogen. The peroxide doubtless has something to do with it, and, perhaps, is itself one of the effects of the action rather than the cause. We do not yet know how silver bromide is changed when it assumes the developable condition, though the evidence is very strongly in favour of a merely physical alteration. Such an alteration seems more likely to result from the impact of some form of radiant energy, than to be the direct result of mere contact with such a substance as peroxide of hydrogen.

The Use of the Optical Lantern.—Projection lanterns are often used in such a manner that one might well suppose that they are regarded simply as "magic" lanterns, and that so long as an enlarged image of the slide is produced on the screen, and that the image is tolerably well defined and sufficiently bright, every desirable condition has been fulfilled. Some, though not many, go so far as to consider the convenience of the audience and endeavour to arrange so that the middle of the screen is, at the highest, about level with their eyes. Still fewer pay attention to what should be one of the simplest and most primary of rules, namely that the image on the sheet ought never to be seen to move or vary in any way in the matter of adjustment. But there is very much more than this in the correct use of a lantern. There is a proper point from which every flat representation of a solid object or view should be looked at, and the skilful or scientific exhibition of a picture renders it at least possible for the observer to see it from this point or from a position at a similar or greater distance. If a three-inch slide is printed by contact from a negative taken with a six-inch lens, the viewing point is always equal to twice the length that the full three inches would be represented by on the sheet. If a twelve-foot sheet would be covered by the three-inch slide, the nearest spectator should be twenty-four feet from the sheet. Under these conditions the view as shown will subtend the same angle (or a less angle, allowing for the spectators who are behind the front row) as the original view did from the position at which it was photographed. But suppose the hall is not large enough to allow of such a distance, some may object. If the distance between the front row and the sheet cannot be more than twelve feet, then bring the lantern nearer and give a six-foot picture, and the conditions are fulfilled. Of course, size counts for something, but mere size, mere exaggeration is contemptible.

The
Late Rev. J. M. Bacon.

We are able to present an excellent likeness of the late Rev. John Mackenzie Bacon, F.R.A.S., whose sudden death at Christmas was so widely deplored. Born in 1846, and educated at Trinity College, Cambridge, he was ordained in 1870, and for some years was curate at Harston, Cambridgeshire. Latterly he had not taken regular duty, but had devoted himself to scientific pursuits. At his home at Coldash, near Newbury, he had a small observatory, and he took part in three expeditions to observe eclipses of the sun. He had

THE LATE REV. J. M. BACON.

also conducted numerous interesting experiments in acoustics and in meteorology. But his name was most widely known as an intrepid balloonist, he having for many years made frequent ascents in the cause of science, often accompanied by his daughter, Miss Gertrude Bacon. He published two books on the subject—"By Land and Sky" in 1900, and "The Dominion of the Air" in 1902.

Mr. Bacon has contributed many interesting articles to "Knowledge," and we now have one in hand on "Seeing beneath the Waves," which we hope to publish very shortly.

Heredity.

The continuation of Mr. J. C. Shenstone's article has unfortunately been crowded out this month, but will appear in our next issue.

SIR WILLIAM TURNER on
The Craniology of the People of Scotland.

By Dr. J. G. McPherson, F.R.S.E.

The learned Professor of Anatomy in the University of Edinburgh has just received the Keith Prize from the Royal Society of Edinburgh for his "Contribution to the Craniology of the People of Scotland."

For several years he has been forming a collection of Scottish skulls with a view of studying the characters of these skulls. He has had considerable difficulty in acquiring a suitable number from which to determine the *type* skull of the Scottish people. A great number of the skulls available to a professor are of necessity from the bodies of the pauper part of the community; and these can give no proper conception of the cranial type of the well-educated and well-to-do classes.

Through the kind interest and help of his many former pupils and friends, Professor Sir William Turner has obtained skulls from definite districts all over Scotland. But Edinburgh, Haddington, Fife, and Mid-Lothian have furnished him with a considerable proportion of the number. He has, in this way, been able to study one hundred and seventy-six skulls outwith the ordinary stock of anatomical specimens; and these represent the characters of the skulls of the people of Central Scotland.

After a very careful and minute examination of these specimens, the Professor drew some definite conclusions as to the form, dimensions, and proportions which prevailed in the crania generally. The shape of the cranium, from its influence on the form of the head and from its connection with the brain which it once enclosed, has for long attracted the attention of anatomists. The relations of the length to the breadth and the grouping of skulls into the "elongated" and the "rounded" have been of much importance in determining the distinctions of the human races. But the Professor has combined observations on the shape of a skull with exact measurements.

The measurements are taken with callipers in straight lines between certain definite points, in order to ascertain the length, breadth, and height of the exterior of the cranial box; with a graduated tapeline over the curved walls of the outer table, the arcs and circumference are determined; and with small shot the internal capacity is known.

Speaking generally, Professor Turner has concluded that the Scottish skull is large and capacious. Its vertex has a low, rounded arch in the vertical transverse plane. Its side walls are not vertical, but they bulge slightly outwards, so that the greatest breadth is at or near the squamous suture.

In the men the longest skull was eight inches, and the shortest $6\frac{1}{2}$ inches, the mean being 7.35 inches. In the women the longest skull was slightly over $7\frac{1}{2}$ inches; the shortest was 6.34 inches—the mean being seven inches. The length of the Scottish skull indicated a brain longer than existed in the long-headed black races.

Professor Turner found that in the men the broadest skull was $6\frac{1}{4}$ inches, and the narrowest 5.12 inches—the mean being 5.86 inches. In the women the broadest skull was six inches, and the narrowest five inches—the mean being 5.43 inches.

Thus the average male skull is longer than that of the female by .35 inch, and broader by .43 inch.

The cephalic index expresses the relation which the greatest breadth of a skull bears to its greatest length. In these skulls examined by Professor Turner, the index ranged from .87 to .68; the mean in the men and in the women being about the same, .77; that is, in the short-headed class. From this it is clear that a strong short-headed strain pervades the population of Scotland at the present time. The Scottish people may be long-headed in calculation and logical acumen, as is often mentioned as a social characteristic; yet anatomically this is not the case.

The vertical index expresses the relation which the height bears to the maximum length. This index ranged from .64 to .79. The mean in the men was slightly more than in the women, approximating .71.

The relations of the length to the breadth and to the height of a cranium have long been recognised as important subjects of investigation in the study of racial characters of skulls; but the relations of the breadth and height to each other have not had an equal attention given to them. In well-pronounced long-headed races like the Esquimaux and Australians, the height is greater than the breadth, forming a high, narrow skull. In the short-headed races, like the Chinese, the breadth is greater than the height, indicating a wide, low skull. A striking feature of the Scottish crania is the preponderance of the cephalic index over the vertical index; accordingly they are of the type "wide low" skull.

Professor Turner's measurement of the horizontal circumference of the Scottish skulls brought out these facts:—In the male, the maximum is $22\frac{1}{2}$ inches; minimum, $19\frac{1}{4}$ inches; mean, 21.9 inches. In the female, maximum, 21.65 inches; minimum, $18\frac{1}{2}$ inches; mean, 20 inches; so that the average horizontal circumference of a man's skull is greater than that of a woman by about two inches. His measurement of the vertical across circumference brought out these facts:—In the male the maximum is $18\frac{1}{4}$ inches, the minimum $15\frac{3}{4}$ inches, and the mean 17 inches; in the female, the maximum 18 inches, the minimum 15 inches, and the mean 16 inches; so that the average vertical transverse circumference of a man's skull exceeds that of the female by an inch.

One of the most important series of measurements was of the total longitudinal arc of the skull (including the frontal, parietal, and occipital arcs). The maximum male skull was 22 inches, the minimum 18.4 inches, giving a mean of $20\frac{1}{4}$ inches; the maximum female skull was 21.1 inches, the minimum 17.3 inches, giving a mean of $19\frac{1}{4}$ inches; so that the average longitudinal circumference of the male skull exceeds that of the female by an inch.

The Professor took the internal capacity of the skull with small shot. And he found among the 115 crania examined (73 males and 42 females), that the maximum capacity in the male skulls was $118\frac{3}{4}$ cubic inches, the minimum $78\frac{1}{4}$, and the mean $94\frac{1}{2}$; in the female, maximum 104, minimum 70, and average $84\frac{1}{2}$ cubic inches. This shows that the female skull is about 10 per cent. less capacious than the male. This agrees with the approximates of the skull capacities of other races and peoples. In a series of comparisons he found that the capacity of the Scottish male skull is somewhat in excess of that ascribed to the crania of European men. He does not, however, conclude from this that the Scottish men have a superior intellectual endowment. Many other factors than the volume of the cranial cavity have to be taken into consideration in the estimation of intellectual power.

In the study of the face it is important to determine the degree of forward projection of the upper jaw. Sir William Turner found that the Scottish skulls are characterised by an almost complete absence of prognathism (projecting jaw). The relation between the height of the nose and the greatest width of that aperture contributes one of the most important anthropological characters of the face. In the males he found the mean height was 2.10 inches, and in the females, 1.96 inches. The width in the males averaged .91 inch, in the females .87 inch. The height, therefore, is more than twice the width; and the occurrence of wide nostrils in the Scottish face may be regarded as accidental, and due, perhaps, to intermixture through an ancestor with that peculiarity. The customary form of nose in Scotland is long, relatively narrow, with a well-marked bridge, and projecting so that the nose distinctly projects beyond a line drawn between the front part of the two cheek bones.

Another important character is the relation between the length and breadth of the face. Professor Turner found the mean length in the males to be 4.72 inches, and in the females, 4.28 inches; he also found the mean breadths to be 5.20 and 4.78 respectively. The breadth of the face is about half an inch greater than its length.

The entire jaw had, in most of the specimens, a massive appearance, which had materially contributed to give character to the face, and from the marked vertical diameter of the body of the bone, had constituted an important factor in giving to the entire face a length which placed it distinctly in the group where the face is high in relation to the width. The lower jaw had a well-defined angle, and the body of the bone was massive on the males, and with a pronounced chin.

Photograph of Electric Spark.

PERHAPS it is not exactly correct to describe this as a *photograph*, since light plays no part in its production. It may more properly be called an "electrograph." The manner in which such representations of electric discharges are produced is as follows:—An ordinary photographic plate, enclosed in two light-proof paper bags (as used in X-ray work), is placed film upwards on a metal plate, which is insulated. The pointed dischargers of an induction coil, in this case one giving a 10-inch spark, are placed a few inches apart, touching the paper envelope. The circuit is then closed, and a single discharge brought about by holding the hammer of the coil and letting it go suddenly. The spark in its passage through the sensitive film decomposes it. The negative is then developed in the ordinary way. Variations of many kinds may be made by dispensing with the metal plate, or by placing the wires one above and one directly below the negative, or by using knobs on the dischargers instead of points.

One of the most interesting points to note is the difference between the positive and negative discharges, the former being "tree-shaped," while the latter is feathery or "fan-shaped." With a single spark both structures are often shown, owing to the oscillatory nature of the discharge. The photograph here reproduced was taken by Mr. Hudson, of Harringay.

Photo by S. C. Hudson,
601, Green Lanes, N.

SPARK ELECTROGRAPH.

Our Sun and "Weather."

By William J. S. Lockyer, M.A., Ph.D.

(continued.)

In confining this study, therefore, to pressure, the first step is to see whether the pressure does change from year to year, and then, if it does, to see if the curves which indicate this change are similar to those which represent the variation in the number of the solar prominences. Taking the Indian region, for reasons previously given, the reader will notice that the Bombay curve in fig. 7 does exhibit short period waves which agree for many years with those on the solar prominence curve; it is important to note, however, that the main eleven-year variation of the prominences is not so conspicuous as the shorter-period changes. The apparent secondary nature of the former and the pronounced character of the latter is a conspicuous feature of pressure curves nearly all over the world. It will be gathered, therefore, that greater attention must be given to this short-period barometric change.

Since the rise in the prominence curve denotes greater solar activity, and this is coincident with an excess of atmospheric pressure over the Indian area, and since this latter means that a greater amount of air than usual is piled over India, some part of the world should be experiencing the reverse conditions; in other words, there should be a large area on which a deficiency of atmospheric pressure exists simultaneously. Now this is exactly what happens, only one has to go to the other side of the world to find the locality. In such a region, then, the curve representing the pressure variation should be the reverse of that of India, that is, when there is excess pressure in one year in India there should be in the same year a deficiency in the other. If the reader will glance at the accompanying diagram (fig. 7) he will see the curve of the pressure variation at the observatory at Cordoba in South America, a locality in nearly the antipodal part of the world to India. This curve is nearly the exact opposite in every detail, and if one be reversed and compared with the other their similarity can be more easily observed.

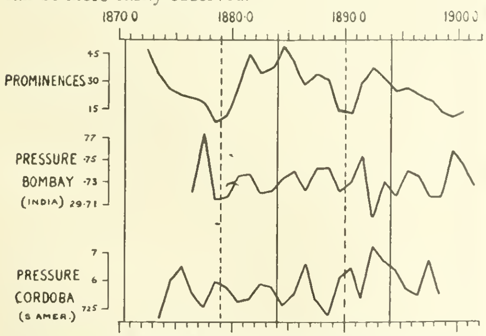


Fig. 7.—Curves to illustrate the wavy nature of the eleven-year prominence change and its relation to the atmospheric pressure variations that simultaneously occur in India and S. America.

The fact that when there is an excess amount of air over the Indian area in some years, and a corresponding deficiency over the Cordoba region during the same years, or a deficiency over India when there is an excess over Cordoba, makes one immediately inquire, What occurs at other places on the earth's surface? Such an investigation has led to some most interesting conclusions. Australia, for instance, like Arabia, Ceylon, East Indies, Straits Settlements, East Africa, Mauritius, &c., behaves like India. On the other hand, South America, the southern parts of the United States, and Honolulu, resemble the Cordoba type of pressure variation. Thus we have the world divided into two portions which behave in opposite ways as regards these barometric changes. As was to be expected, those regions neighbouring the limits of these two large areas are somewhat indeterminate, and sometimes favour the one and sometimes the other. The accompanying map (fig. 8) will convey at a glance this pressure distribution, the Indian and Cordoba regions being indicated by a (+) and (−) respectively; the indeterminate areas are shown by a (± ?). The latter can be easily seen by following the track of the neutral line which approximately divides the eastern and western hemispheres.

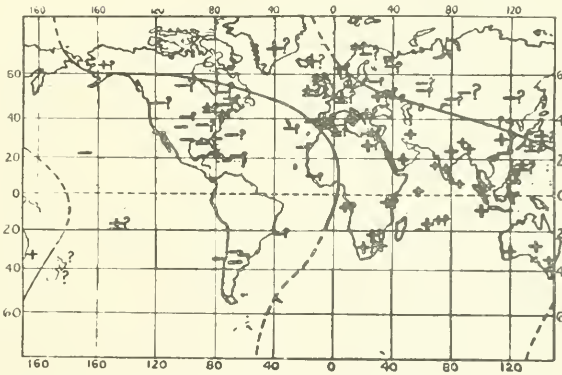


Fig. 8.—Map illustrating the positions of the two large pressure area types, namely India (+ and +?) and S. America (− and −?), which behave inversely to each other. The neutral line approximately divides the earth into two equal portions.

The detection of this pressure variation may turn out to be an important clue to the close connection between the meteorological behaviour of regions which are widely separated. Thus to mention one of many incidences, Sir John Eliot has recently pointed out that the drought in the Indian region during the years 1895-1902 was a more or less general meteorological feature of the whole area, including Abyssinia, East and South Africa, Persia, Baluchistan, Afghanistan, probably Tibet, and the greater part or whole of Australia. Since these areas all lie within the Indian type of pressure variation above described, their meteorological connection seems undoubted.

Many people are more familiar with rainfall variations than they are with those of pressure, so that the importance of the latter can best be shown by indicating how rainfall is affected by pressure. As a general rule low pressure means increase of rain, but this is not always the case. The main point to be considered in this connection is the nature of region, that is, whether it is land or water over which the air current has passed, before it reaches the area in question. Thus what may be a rain-

bearing current for one part of a continent may under similar low pressure conditions be a dry one for other parts and *vice versâ*. The lie of the land in relation to the water surface must, therefore, in every case be taken into account, and it is for this reason that the direction of the prevailing winds becomes one of extreme importance.

In the first place, let the pressure and rainfall of the west coast of India and Ceylon be compared, but in both of these cases the rainfall of the south-west monsoon period will be dealt with alone. India, as is well known, receives its greatest quantity from the strong moist air current which strikes the country from its south-west quarter. The strength or weakness of this current means prosperity or poverty to the country. A failure of these rains foretells for many districts a terrible drought and consequently loss of crops, a famine, and a great expenditure of money. Since the west coast of India is most exposed to the south-west monsoon wind, and is not shielded by mountains except on its eastern side, this region should respond in its rainfall to the pressure variations. In the Ceylon rainfall curve only those months have been included during which the south-west monsoon wind is blowing.

In order that the reader may more easily compare curves of pressure with those of rainfall, the former have been inverted. The highest points of the pressure curves therefore mean lowest pressures, and these correspond with the peaks of the rainfall curves which denote years of greatest rain. A glance now at the accompanying diagrams (Fig. 9) will illustrate the close resemblance between these two meteorological elements. In both the rainfall curves similar kinds of variations seem to exist, but the rainfall of Ceylon appears to anticipate to a small extent that of the western coast of India. Thus years of low pressure for these regions mean, on the average, years of good monsoon rains.

Now, not only does this connection hold for this portion of India, but the same happens in the case of some parts of Australia. Years of deficient pressure there mean years of excess rainfall. Since

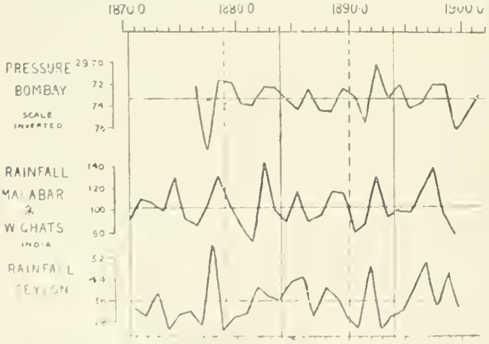


Fig. 9.—Curves to show the relation between years of low pressure over the India area and the rainfall on the west coast of India and Ceylon during the South-West Monsoon period.

the pressure variations are nearly similar to those in India, good rains should occur in the same years. The annexed diagram (Fig. 10) shows the state of affairs at Adelaide, Perth, and Albany, the pressure curves of all these places being very similar. Excess low pressure corresponds to excess rainfall. What lack of rain means to this colony only those who have experienced a droughty season there can vividly testify; but the millions of sheep that have died through want of water in the last few years indicate the importance of the value of rain.

In our own isles a similar relation of pressure and rainfall holds good. Low pressure on the average means a greater number of cyclones, while high pressure means anti-cyclonic conditions on the average. The rainfall of Great Britain on the whole is chiefly dependent on the

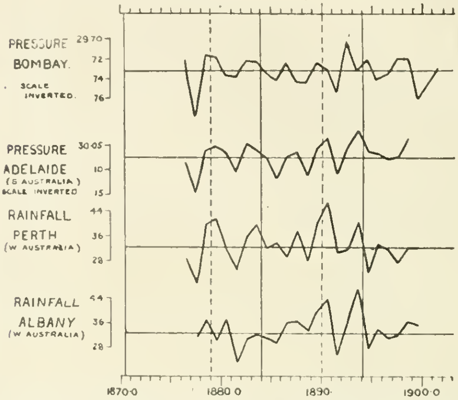


Fig. 10. Curves to show the close relation between the pressure variations in India and Australia, and the rainfall in the latter country.

winds which reach this country from the Atlantic, that is south-west winds, or, in other words, on cyclones which pass over the country in a direction north-eastwards. Since cyclones denote low pressure areas, the rainfall is directly dependent on pressure. A perusal of the accompanying diagram (Fig. 11) shows how intimate this relationship between rainfall and pressure is, for the curves (the pressure curve is here inverted) are so very closely similar.

Unfortunately, the British Isles, which display pressure variations intermediate between India and Cordoba, are a sort of half-way house, and have therefore rather a mixed type of pressure variation; there is thus some difficulty, with our present knowledge, in foretelling a year in advance whether the pressure will be in excess or deficient.

Although this short-period variation of pressure is, perhaps, the most important that is indicated in meteorological observations, and the reader can judge this from the curves here shown, it is not the only one acting. In many cases that have been examined, the most distinct variations are those which extend over several years, and correspond to the thirty-five year sun-spot variation previously described, and to that covering about eleven years. The prominence record is not sufficiently long to say whether this class of solar disturbance has a period of variation of thirty-five years, but the eleven-year change is most pronounced.

The thirty-five year weather cycle, or Brückner cycle, as it is called, because Brückner was the first to clearly demonstrate its existence, has for many years been suggested. Thus Bacon many years ago wrote: "There is a toy which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the low countries that every five and thirty years the same kind and suit of years and weathers come about again; as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like, and they

call it the Prime." Again, in Australia there was an impression as long ago as the year 1836 that the seasons underwent a variation every nine or ten years, varying, however, every third series or thirty years.

Now Brückner has shown that there is a thirty-five year period both in pressure and rainfall, the years of high pressures corresponding to those of less rainfall. This long-period variation is of very great importance and must be reckoned with in long-period forecasting, although it is not so prominent as the short-period

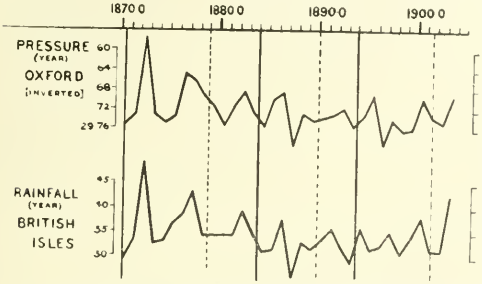


Fig. 11.—Curves to illustrate the close relationship between the variation of pressure over the British Isles (Oxford taken as the type) and the mean rainfall, from the Meteorological Office Statistics, over the whole of Great Britain.

changes that have been described above. The accompanying set of curves (fig. 12) will perhaps serve to illustrate this long-period variation of rainfall for a few stations on the earth's surface, while the curve at the top indicates the relationship between the epochs of the dry and wet periods and those of the great solar variation of thirty-five years described in a previous paragraph. It must not be forgotten that to determine this long-period variation from the rainfall records the means of several years have to be taken together, and even when every five-year values have been employed the resulting curves have to be again "smoothed," as it is called. In some of the cases it will be seen that the five-year means render apparent the eleven-year variation, a variation which seems more distinct in tropical regions, such as India, than extra-tropical regions.

A glance at the curves is sufficient to indicate the existence of these variations. From a study of these variations at many places scattered over the earth's surface, it has been found that the maxima or minima do not occur at the same epochs at all places; at present this question has not been worked out, but it may possibly turn out that, like the short-period pressure variation, there is a give and take between two large regions on the earth, in which while the maximum rainfall is occurring in one region the minimum is taking place in the other.

Fortunately for us who dwell in Western Europe, it will be seen from the curves that we are entering on a series of years, which, *on the average*, will be wet, after having just experienced a number of years during which the rainfall was very much below normal. The rainfall of 1903 practically put an end to this long drought. It is important to remember that the short period of about four years is the most prominent variation of rainfall, and is always at work. It is thus quite possible to have a comparatively dry year when the long-period rainfall variation is at a maximum, but on the average the wet years will be wetter and the dry years less dry at such an epoch. At the minimum of the long-period cycle the wet years will be less wet and the dry years more dry.

Enough, perhaps, has been said to show that the rainfall variations all depend on the atmospheric pressure changes that occur. These latter are apparently closely associated with the solar cycles whether they be indicated by spots or prominences. We are thus led to deduce the most probable—and, after all, the most natural—conclusion that the sun is the most important factor in producing our varied weather.

We have become acquainted with three periodic variations of solar activity, covering about four, eleven, and thirty-five years each. The question arises—Are there any other variations of longer period which may help to complicate the solar problem, and, consequently, the meteorological one as well?

It may be said, however, that no other periodic variation extending over a year has yet been traced, as the time over which the observations extend is at present too short.

The lengths of the periods which have up to now been discovered have, however, such a peculiar relationship to each other that perhaps a means is afforded of suggesting a fourth period. If we take the length of the shortest period as our unit—namely, 3·8, and multiply it by 3, we obtain 11·4, which is very near our second period, which is 11·3; if we again multiply 11·4 by 3, we have 34·2, which again is close to 34·8, the real value, as far as can yet be determined, of the thirty-five period. Now, if we multiply 34·2 by 3 again, we obtain 102·6, which may be the length of a new period. The above numbers, put in

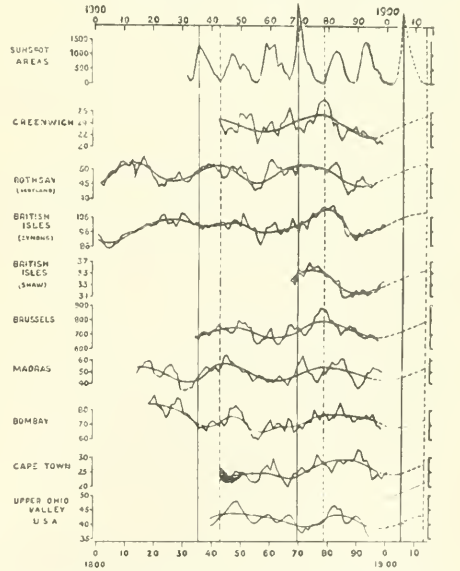


Fig. 12.—Some curves showing the long-period variations of rainfall and their relation to the 35-year solar change as indicated by the vertical dotted lines, and the eleven-year solar period.

tabular form, show the curious relationship between the periods perhaps better:—

$3·8 \times 1 =$ 3·8,	value actually determined	3·8
$3·8 \times 3 =$ 11·4	,, ,, ,,	11·3
$3·8 \times 6 =$ 34·2	,, ,, ,,	34·8
$3·8 \times 9 =$ 102·6	,, ,, ,,	?

To advance the knowledge of weather changes, solar variations must be most carefully watched. For a successful solution of the weather problem, the two sciences, Solar Physics and Meteorology, must go hand in hand, and the saying "unity is strength" no less applies to matters scientific than it does to other affairs of life.

Water Finding with the "Divining Rod."

As a result of Prof. Wertheimer's announcement that he was about to undertake some careful investigations in the subject of water-finding by so-called "dowsers," quite a number of letters and articles have appeared in the *Times*, showing how widespread is the interest in this matter. These letters, too, when read as a series, give a very good idea of how the question stands. There are undoubtedly many people, and many of scientific experience, who seem to be firmly convinced that there is "something in it." Many of these are themselves "dowsers," though unable to assign any cause to the manifestations. Then, on the other hand, there are those disposed to ridicule the whole affair as an absurd superstition. But probably the majority of thinking people are of a medium opinion and are only anxious for evidence to convince them one way or the other.

The case for the unbelievers is soon summarized. There is almost as much evidence, as far as can be ascertained, of failures to find the predicted spring, as of successes. If one points haphazard to any spot on the ground, and a well be sunk at that place, there is a very good chance of water being met with. This probability, combined with a due consideration of the geological and topographical features, will be sufficient to enable a professional water-finder to make a good reputation. If he has the luck to hit off the right spot his fame will soon be spread. If he fails, the affair is soon forgotten.

But now let us assume that the marvellous manifestations have been fully and truthfully recorded. If certain persons, and only a limited proportion of mankind, possess the remarkable gift of being able to hold a twig in their hands in such a way that it shall be caused to violently rotate when held above a subterranean spring of water, then we are undoubtedly in the presence of an extraordinary force, the nature of which is entirely unknown to us.

In searching for a solution of the mystery there are two distinct propositions to be considered, since typical "divining" is only supposed to be possible when two factors are suitably combined. These are, a person endowed with the mysterious power, and a forked stick of certain dimensions and even a particular kind of wood. Sometimes, however, it is said that a wire or steel spring will do as well; while occasionally a "dowser" will declare that he can even tell of the presence of water without anything more than his open hand.

It is most unaccountable to suppose that a hazel twig of a particular shape and size should be affected while one of another sort of wood or slightly different form should not be affected. And the fact seems so contrary to nature and so little supported by scientific evidence, that we may, perhaps, dismiss this factor from investigation.

Then, again, there has to be considered the method in which the rod is held in the hands. It is usual to hold it in one particular way, and herein, it seems to us, is some slight clue. It will be found that if a forked stick of the usual dimensions be held in the orthodox manner, that is, with the tips of the forks enclosed in the palms of the upturned hands, a very slight movement of the hands in a particular way causes the base of the fork to revolve right round, and thus an almost unconscious pressure of the hands will often have an extraordinary effect. This can easily be appreciated by anyone even while sitting in one place and nowhere near any water, holding such a stick and trying to keep it pointing downwards, say for 10 minutes, on end. It may be, then, that a very slight convulsion of the nerves causes the stick to move. In other words, it seems probable that the divining rod is but an index of slight nervous sensations.

Then as regards the power of water-finding being confined to certain persons. This, unless it be that some people's nerves are more "highly strung" and more susceptible to be affected than others, seems quite contrary to all we know of the human frame. It is much more likely that only a few persons happen to have been successful, and are thenceforward supposed to possess the extraordinary faculties. Undoubtedly many people are exceptionally sensitive, for instance, to atmospheric variations. Old wounds and corns frequently indicate some change in the conditions quite beyond recognition by our other senses, and this is a subject that does not appear to have been at all thoroughly investigated.

We now seem to be arriving at a more rational problem. The next question to be considered is as to how the presence of a subterranean spring of water can be detected by the nerves. It is a matter of everyday occurrence to see, on still evenings, light mists hovering over the grass in particular places, and it seems not at all unlikely that such mists will usually be found suspended above the position of some underground spring. Is it, then, not probable that this patch of humidity can be ascertained by instruments even when the state of the atmosphere is not favourable to the formation of a visible mist? And if the air in this spot is different as regards humidity, temperature, or other property to that surrounding it, is it not possible that human nerves may be so affected that some very slight difference is felt? And if this is the case it is not difficult to suppose that someone holding a twig in a constrained position might find that in passing into such an atmosphere there was some slight relaxation or contraction of the muscles, and this would undoubtedly cause the twig to revolve. One of the correspondents also mentions how gnats are seen to congregate over particular spots. Whether this is due to dampness of air or other cause has, we believe, not been well ascertained.

Sir William Preece, in the *Times* of the 16th, brings forward another theory. He suggests that the running water may set up slight vibrations of the ground, which, he thinks, may act upon "the sensitive ventral diaphragm of certain exceptionally delicately-framed persons."

But then we also read statements that the same manifestations occur when, instead of water, a small quantity of gold or other precious metal is present. In this case we either feel that a very strong addition is made to the case in favour of the whole matter being a fraud or a delusion, or else that the mystery is one altogether too profound for us to attempt to apply the known laws of nature. One correspondent, indeed, tells of "a respectable farmer in this neighbourhood who could tell under which of several hats a sovereign had been placed." We know of many people who can do this, but without the aid of the divining rod. There is, however, much evidence as to the finding of lodes of metal ore. Another correspondent declares that he himself can locate lodes of copper or tin ore, and has done so with great success. If metalliferous ores can affect the hazel twig, the suggested theories of

humidity and vibration are quite inapplicable, and we must search for some further cause. Some people have vaguely ascribed the results to electrical manifestations, but ignorant people have a way of imputing (often, perhaps, with some truth) all unaccountable phenomena to electricity.

However, the subject is an interesting one and well worth careful investigation, and as Prof. Wertheimer has kindly promised to send us the results of his investigations, we shall look forward with much interest to the report. The *Times* suggests that "half-a-dozen men of ordinary ability, powers of observation, and common sense, could settle the whole question by putting half-a-dozen 'water-finders' to the test." If they clearly proved the dowsers at fault the whole question might be fairly settled, but if the water should invariably be found where predicted, the question would be very far from being settled. We would suggest that a beginning might be made, as it were, at the other end; that is to say, to conduct some careful scientific observations as regards the hygrometric, thermometric, electrical, and vibratory conditions of the earth and air at a spot beneath which a spring of water was known to exist. If peculiar conditions were found to exist, then we would know that there might, after all, be something in hnman "water-divining."

CORRESPONDENCE.

The Great Red Spot of Jupiter.

To the Editors of "Knowledge."

Gentlemen,—In your note on p. 13 of the current number of "Knowledge & Scientific News," you are good enough to refer to some recently-published results by the writer relative to the motion of the above spot. May I, however, point out that my observations and conclusions are in agreement with those of Mr. Denning, and that they do not really "seem to indicate very different results," as stated in yonr note? The rotation period found here for the red spot in 1902 is 9 h. 55 m. 39·66 s., and for 1903 it is 9 h. 55 m. 41·52 s. Mr. Denning's figures for the same two years are 9 h. 55 m. 39·4 s. and 9 h. 55 m. 40·8 s. respectively (see the *Observatory*, 1904, p. 343). It will be seen that both Mr. Denning's observations and those made here indicate a distinct increase in the length of the rotation period. The shorter period of 9 h. 55 m. 38·6 s. ascribed to Mr. Denning refers to the first seven or eight months of 1904, and seems to be due to further vagaries in the motion of this truly remarkable spot.

Mr. Denning, I believe, observed the great hollow or bay in the south equatorial belt of Jupiter, nearly opposite to the red spot, whilst the spot itself was observed here. The periods of time over which the observations extended are also probably not exactly the same. These circnmstances will probably acconnt for mnch of the not very large differences between onr figures quoted above. I believe that a shortening in the length of the rotation period of the red spot for the first seven or eight months of last year, similar to that pointed out by Mr. Denning, will also be shown by my observations, bnt these are still in progress, and I am anxious to avoid, as far as possible, making any examination or comparison of the results obtained until the close of the present apparition of Jupiter, so as to avoid being biassed as much as possible. The Rev. T. E. R. Phillips confirms, however, the more rapid motion of the spot in the first seven or eight months of 1904 (see *Journal. B.A.A.*, Vol. XV., p. 28). How far these somewhat curious changes in the motion or drift of the red spot are real, and how far they may be only apparent, and due to the changed surroundings of the spot, must be left to future consideration.

A. Stanley Williams.

20, Hove Park Villas, Hove,
January 9, 1905.

NOTES.

ASTRONOMICAL.

A Sixth Satellite of Jupiter.

During December last, Professor Perrine, of the Lick Observatory, suspected the existence of a new satellite, but it was not till early in Jannary that observations made with the Crossley reflector confirmed his suspicions. The distance from the planet was much greater than that of any of the other satellites, being then 45′. The motion of the satellite was reported to be retrograde, presumably referring to its apparent motion in the sky, and not to its orbital motion. It has a magnitude of 14.

* * *

Observations of Meteors.

Systematic observation of meteors was conducted at Harvard Observatory on November 14-15, four observers watching while an assistant wrote down the records. In this way 275 meteors were recorded. Thongh the heads at the time of explosion were usually blne or white, in two cases at least they were red or orange, which difference in colouring is ascribed by Professor Pickering to variation in chemical constitution. Elaborate preparations were also made to photograph the meteors, but only two trails were recorded on the negatives exposed.

* * *

Eclipse Expeditions.

Three expeditions are being arranged in connection with the Lick Observatory for observing the total eclipse in August. The cost of them will be borne by Mr. William H. Crocker. One is to go to Labrador, a second to Spain, and a third to Egypt. Photographs will be taken to endeavour to ascertain the existence of an inter-mercurial planet in addition to the photographing of the corona.

Death of Mr. Crossley.

The announcement of more important discoveries by means of the Crossley Reflector at the Lick Observatory has just been followed by that of the death of the donor of that great instrument, Mr. Edward Crossley, the Chairman of a great carpet manufactnring firm of Halifax, Yorkshire.

BOTANICAL.

By S. A. Skan.

The New Zealand Institute has lately issued Vol. XXXV. of its Transactions, which, like many of its previous ones, contains some important and extremely interesting papers relative to the botany of New Zealand and the neighbouring islands. We are reminded in Mr. W. W. Smith's communication on the "Plants Naturalised in the County of Ashburton" of the extraordinary number of alien species which have established themselves in New Zealand. In Ashburton the naturalised species number 368, of which as many as 95 per cent. belong to the Scandinavian flora. Many of our familiar weeds are abundant in this distant Colony, where they often flourish to an extent rarely known in their native country. A thistle (*Carduus lanceolatus*), Mr. Smith tells us, grows so vigorously in Ashburton that some places are rendered impassable, even on horseback. The late Professor Kirk, writing in Vol. XXVIII. of the Transactions, estimates the number of naturalised species in New Zealand as over 500, and he described the

remarkable effects on the indigenous vegetation brought about by their introduction. When Cook and Vancouver visited New Zealand the constituents of the fauna and flora were, Professor Kirk observed, very probably in much the same condition as they had been in for many previous centuries. Altered conditions following the immigration of white people, the felling of forests, agricultural operations, and the introduction of various animals, many of which proved particularly destructive to vegetation, rapidly made a marked impression on the native flora. The clearing of the ground often meant the practical extermination of indigenous species, while it favoured the growth of aliens, seeds of which had been introduced in various ways, often mixed with agricultural seeds, in ballast, or by means of animals. That the stronger-growing species among the newcomers should spread and crush out of existence the weaker native plants is not remarkable, but we are told that the small slender-growing European grasses and clovers have in places succeeded in displacing such stout plants as *Phormium tenax*, the New Zealand Flax, and *Cyperus ustulatus*, a robust sedge. Rabbits and sheep have proved disastrous to many species, especially those with very local distribution. *Epilobium brevipes*, when Professor Kirk wrote, was restricted to two localities, and could easily at any time have been exterminated by a hungry rabbit or sheep. *Clianthus puniceus*, a handsome leguminous plant, is now confined to one or two small islands, where it owes its preservation to the absence of sheep. Both writers have noticed that many of the naturalised plants, after a period of remarkable vitality and vigour, diminish in strength and numbers and sometimes disappear altogether.

An account of a botanical excursion to the Southern Islands of New Zealand is given by Dr. Cockayne. These islands include the Auckland group, Campbell Island, the Antipodes and Bounty Islands. The visit was made during mid-winter, which enabled the author to note some previously unrecorded features of the vegetation. In Auckland Island, at about 50° 45′ south latitude, a single specimen of a common New Zealand tree-fern (*Hemitelia Smithii*) was found. This is a particularly interesting discovery, for it considerably extends the southern range of these plants. Hitherto the known limit for tree-ferns was about 47° south latitude, where, at Port Otway, in Patagonia, *Alsophila pruinata* has been met with. Both these species may be seen in some of our botanic gardens. An enumeration of the species native of the islands, with a full bibliography, concludes a most valuable treatise on insular floras.

* * *

Supra-terrestrial Vegetation.

An article is contributed by M. Virgile Brandicourt to the *Revue Scientifique* on "supra-terrestrial" vegetation, plants which grow, not on the surface of the earth, but on walls, and roofs, and trees. They form an interesting study. The oldest of them are those that grow on stone and brick walls. Sixty-seven per cent. of these are plants with fine seeds (saxifrage, arenaira, urtica, &c.), 13 per cent. plants with winged seeds, that are easily dispersed by the wind, 9 per cent. plants with fleshy fruits, 6 per cent. plants with hooked seeds, and 5 per cent. plants with an explosive mechanism for dispersing the seeds. The plants of thatched roofs are also numerous. Some of the older thatched roofs have from 15 to 16 species of plants, and the general average is eight. There is a special flora characteristic of the tops of pollard willows. As many as 86 species have been catalogued which grew thus. The most curious instance of a parasitic tree was communicated by Dr. Magnin. A mulberry tree took root on an ash, and usurped its place by pushing the ash's trunk down little by little till it was lost to sight.

METEOROLOGICAL.

Meteorological Figures.

An attempt is made by Dr. Kappen, in the German meteorological review *Das Wetter*, to express a mathematical relation between the intensity of heavy rainfall and the time which it lasts. He makes out a constant "n" for the relation, "n" being equal to the square root of the time multiplied by the intensity. By a curious coincidence the French meteorological review, *Le Temps qu'il Fait*, has an article on recorded great falls of rain, or, perhaps, we should say great "cloudbursts." On August 20, 1900, 30 mm., or well over an inch of rain, fell at Maredsous in ten minutes. The greater rate of fall recorded was, however, at Turnhout on July 10, 1899, when 25 mm., or nearly an inch, fell in six minutes, which gives a rate of 4.2 millimetres a minute. In these heavy rainfalls the distribution is very erratic. Thus, on August 27, 1902, during a storm which swept Paris, 50 mm., or not far from two inches, fell at the Parc des Buttes, Chaumont, and less than a quarter of an inch at Mont Souris.

* * *

The Velocity of the Wind.

At the Eiffel Tower, during a storm on the night of the 11th-12th of September, 1903, a rate of 42 metres a second (94 miles per hour) was recorded, but this record was eclipsed in 1894, when on the 12th of November the wind attained a velocity of 48 metres per second. America, however, cannot be beaten in such matters. On the 18th of May, 1902, a storm visited the Pacific Coast, and near San Francisco the wind was measured as travelling during several minutes at a speed of 53·6 metres a second. Since the velocity undoubtedly as a rule increases with altitude, it is not surprising to find that on the summits of high mountains still greater speeds have been recorded. M. Brunhes, the Director of the Observatory on the Puy de Dôme, claims the record wind velocity, for on the 9th of December, 1901, between 10.20 and 10.30 it blew at a mean rate of no less than 70 metres a second, or 156 miles an hour.

* * *

London Fogs.

The report of the Meteorological Council upon "an Inquiry into the Occurrence and Distribution of Fogs in the London Area, during the Winters of 1901-2 and 1902-3" has just been issued. It is, of course, past our understanding why such a report should take nearly a year to compile, but we must rest satisfied that such tardiness is not unusual with similar reports, and that doubtless there was good reason for it. During the last winter observations of the fog were recorded at 46 stations, and thermometers were supplied to thirty fire brigade stations, in order to determine the variations of temperature prevailing. Among the various supposed causes of fog, radiation from the earth's surface during calm nights is found to account for the majority. Warm air passing over previously cooled surface causes many others, while "cloud fogs" form a third class. There is no evidence to show that, in London, geological formation affects the formation of fogs, and while fogs on the river and in the open parks were frequent, it has not been found that the neighbouring districts were specially infected.

As regards forecasting the presence of fog, it is pointed out how much more valuable night observation and early morning reports would be than the present system of issuing the forecast at 6 p.m.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Flamingoes on the Medway.

The *Field*, Dec. 24, reports the occurrence of flamingoes presumably *Phœnicopterus roseus*—on the Medway. A young male "was recently shot on the marshes close to Gillingham," and mistaken by the shooter for some kind of goose! It is reported that another has been seen.

Although there can be no doubt that some of the recorded occurrences of this species should be cancelled as escaped birds, at least three previous instances of wild birds taken in this country must be allowed to stand. Nevertheless, so good an authority as Mr. J. E. Harting refuses to admit the Flamingo to the list of British Birds.

The Breeding of the Knot.

The *Ibis* for January contains a short but interesting account of the discovery of the hitherto unknown eggs of the Knot (*Tringa canutus*). A nest of this species, containing four eggs, was found on June 17, 1898, in the Island of Hrisey, to the north of Iceland. The bird was breeding with several pairs of *Tringa maritima*—the Purple Sandpiper—and was kept under close observation for some time before the eggs were taken. It was not killed, as the collector hoped to have the good fortune to obtain a second clutch.

The eggs are described as "quite like very large eggs of the Dunlin (*Tringa alpina*), of the closely-spotted type, and cannot be confounded with any others of the same size."

* * *

The Pacific Eider at Scarborough.

An adult male of the Pacific Eider, *Somateria V-nigra* was killed during December at Scarborough. This is the first authentic instance of the occurrence of this bird in Great Britain. Closely resembling our common Eider, *S. molissima*, it may be distinguished therefrom by the V-shaped mark on the throat, and the bright orange colour of the bill.

The Pacific Eider is found in great numbers in North-Western America and North-Eastern Asia.

* * *

Peregrine Falcon in Essex.

A fine female of this Falcon (*Falco peregrinus*) was killed at Tambridge, Essex, during the first week of January. It is a pity that these handsome and rapidly-vanishing birds cannot be protected more completely.

PHYSICAL.

More Failures with N-Ray Experiments.

MM. Chanoz and Perrigot have been attempting to repeat an experiment made by M. Bordier, who showed that N-rays emitted by tempered steel could apparently be detected by photography. The former, however, found that equal sized pieces of steel and of lead, placed on exactly similar screens, and exposed for various periods, never gave different halos, as described by M. Bordier.

* * *

Solid Electrolytes for Accumulators.

The usual acidulated liquids employed in accumulators have many disadvantages, especially when the cells are carried in motor vehicles or in other circumstances where they may be subjected to much shaking and vibration. The liquids are liable to be spilt or to penetrate through stoppers and corrode the terminals or wires and cause other annoyances. For this reason they have sometimes been replaced by pastes or jellies.

M. Schoop, who has lately been experimenting in this line in France, gives the following preparation as one very suitable for the purpose.

1. A solution of sulphuric acid in distilled water, having a specific gravity of 1·22.
2. A solution of silicate of soda, free from chloride, in distilled water, with a density of 1·20.
3. A "bouillon" obtained by boiling for two hours in an enamelled receptacle one kilogramme of asbestos card with two litres of water acidulated with 10 per cent. of sulphuric acid. The cardboard disintegrates and is washed over a filter with distilled water, and is then squeezed as dry as possible by hand so as not to retain more than one-third its weight of water. Take 18 litres of the acid solution No. 1, add 450 grammes of the wet asbestos fibre, and thoroughly mix in a glass or ebonite vessel. Rapidly pour in $4\frac{1}{2}$ litres of the solution No. 2, and stir until it assumes an oily appearance. Then pour the composition into the accumulator, the plates having been moistened with acidulated water, and leave for 24 hours to settle. The liquid gradually thickens, and finally becomes a solid jelly.

ZOOLOGICAL.

By R. Lydekker.

The Position of the King Crab.

According to Professor E. Ray Lankester, who has been lately discussing its affinities and systematic position, the King Crab (*Limulus*) of the Moluccas is a misnamed creature; for, in spite of its somewhat crab-like shell, it is not a crab at all, but rather a near relative of the scorpions, which are first cousins of the spiders, and are consequently included in the class *Arachnida*—a group of equal rank with the crustacea, or crabs, lobsters, &c. The extinct trilobites, which have also been classed as crustaceans, are likewise included by the same authority in the *Arachnida*, of which, however, they form a brigade of equal rank with the one comprising all the other members of the class.

* * *

The Coloration of Animals.

In a paper on coloration in mammals and birds, by Mr. J. L. Bonhote, recently published in the *Journal* of the Linnean Society, the author suggests that colour in the members of these groups is primarily due to activity of nutrition and function, or, in other words, "vigour"; and consequently that where conditions are favourable to a high state of vigour in animals, there the majority of species will be brightly coloured, and, of course, *vice versa*. Vigour he believes to be dependent on two chief causes, namely, climate (which is taken to include both temperature and food) and the rise and fall of sexual activity. In polar regions, where the two causes operate together, the changes are violent; in the tropics, on the other hand, the effect of climate is practically *nil*, and changes in colour are consequently due in the main to sexual causes. The occurrence of dark-coloured animals, like the musk-ox, in arctic climates is explained by special specific vigour. The "bleaching" of the hair of mammals and the feathers of birds is regarded as an active process, and not merely the effect of "weathering."

Natural selection and protective coloration take, in the author's opinion, a secondary position, because, although undoubtedly important factors, they are only able to make use of such colours or to modify such markings as have been produced by vigour.

* * *

Papers Read.

The most important event at the meeting of the Linnean Society, held on December 1, 1904, was a discourse by Professor S. H. Vines on proteid digestion in animals and plants. At the meeting of the same Society on December 15, Mr. C. C. Hurst communicated notes on heredity in rabbits, based on crosses between a Belgian "hare" and an albino Angora; and on January 19 Dr. W. G. Ridewood read a paper on the osteology of the skull in the bony fishes of the families *Osteoglossidæ*, *Pantodontidæ*, and *Phractolæmidæ*. At the meeting of the Zoological Society on December 13, Mr. O. Thomas exhibited skins of a gazelle from Palestine, which he regarded as indicating a new species. The important feature of the meeting was, however, the exhibition by Mr. Rothschild of a large series of mounted skins, skeletons, and skulls, illustrative of a paper on the man-like apes, in the course of which the author described the gorilla of the South Cameruns and the white-faced chimpanzi of the Gabun as new. Dr. Ridewood contributed a paper on the skulls of the herring-like fishes, Professor Minchin discussed the British sponges of the genus *Leucosolenia*, Mr. Blanford described a number of land-shells of the genus *Macrochlamys* and allied types, and a communication from Mr. M. Jacoby was read containing descriptions of beetles of the family *Hallicidæ* from South and Central America. At the meeting of the same Society held on January 17, Mr. W. F. Lanchester contributed three papers dealing with annelids and other invertebrates from the Malay Peninsula and Zanzibar; Mr. A. D. Jenner discussed the minute teeth on the palate and gullet of sharks and rays; and Mr. Beddard read one paper on the anatomy of the Australian frilled lizard (*Chlamydosaurus*) and its allies, and a second on the brain of the black ape (*Cynopithecus niger*) of Celebes.

REVIEWS OF BOOKS.

Biochemistry of Muscle and Nerve. W. D. Halliburton, M.D., F.R.S., pp. 160; price 7s. 6d. net (London: John Murray, 1904.).—This book consists of a reprint of two courses of lectures delivered in London and the Herter lectures delivered in New York. For the material of the book we have nothing but eulogy, but the arrangement leaves something to be desired. The book is really a republication of experimental lectures, and in the book Dr. Halliburton describes experiments which he was actually performing in the lectures. The reader of the printed pages cannot, however, see the performance of the experiments, and finds it a little exasperating to read: "Let me now show you with this other freshly-killed rabbit another way of making muscle plasma. . . . The iron lemon-squeezer is very effective for the purpose. You see the drops of muscle plasma." . . . And so on. Surely it would not have taken a great deal of trouble to alter the tense when preparing the lectures for press. This is our only adverse criticism, for the rest we hardly know where to begin, the book is so interesting. The first lecture is more or less introductory, and opens with an account of the composition of the muscle. A description is given of the manner in which proteids can be separated from each other, in the first place by fractional heat coagulation. This was demonstrated before the audience in the case of muscle plasma, the first coagulation taking place between 42° and 47°, the second coagulation at 56°. Another method being that of salting out with ammonium sulphate. "Thus half saturation with ammonium sulphate (one of the most frequently employed of the neutral salts for the fractional precipitation of proteids) will precipitate globulins; complete saturation with this salt is necessary to precipitate albumins." Lecture II. deals with heat rigor. A muscle loses its irritability and contracts permanently when gradually heated to a certain temperature, this being due to the coagulation of the proteid material of the muscle. Diagrams are given showing that the contractions at different temperatures correspond to the coagulation temperatures of the various proteids. Chemists will find Lecture IV. one of the most interesting. It treats of the "extractives and salts of muscle." It should also interest athletes, because the author refers to the feeding of those in training, and explains that, although muscle works most economically when chiefly fed on proteids, during recent years feats of great endurance have been carried out by men fed mainly on carbohydrates. Most readers will probably remember the feats of marching undertaken by the German Army upon a food consisting of a few lumps of sugar or of chocolate. It appears, therefore, that a more or less mixed diet is probably the best. "Metabolism in Nervous Tissues" is the title of the seventh lecture, and is illustrated by a number of very useful diagrams. The study of the metabolic activity in nervous tissues involves the discussion of fatigue and sleep. It is interesting to note that whereas large doses of carbonic acid act upon the nerves as an anæsthetic, and therefore abolish electrical response, small quantities increase its activity. "A nerve thus forms a very delicate test object for this gas; far more delicate, in fact, than most chemical reactions are." Another point of interest is the demonstrable fact that fatigue takes place in the nerve centres and in the peripheral endings of nerve fibres, but the nerve fibres themselves appear to be non-fatiguable. The book interests us so much that we are tempted to give quotations from nearly every page. This would not be fair to the author, and the Editors of Knowledge would probably object from reasons of space. Every medical man and others who, although not having special medical training, have scientific training, should read this book. The author knows how to bring out the salient parts of his subject with incisive clearness, and the fact that so much of the work has been carried out by himself and co-workers adds very greatly to the value of the book.

Bacteriology and the Public Health. By George Newman, M.D. Third edition: John Murray.—There are so many points of contact between public interest and the science of bacteriology that a book which views the present knowledge of bacteria from the standpoint of public health has claims to consideration from every side. It is in the highest degree important that scientific men who have the ability to do so should present to the popular mind in a clear and convincing manner the bacteriological processes on which we rest our treatment of some diseases, our sanitary measures and precautions, and our scientific treatment of food stuffs. To take one example from several others in Dr. Newman's chapters, there is the question of immunity from disease. The bacteriological principle of immunity, divested of the many complexities with which Ehrlich and Welch and others have sought to clear up certain difficulties and contradictions, is briefly this: That when the blood is infected with any bacterial poison a specific antidote is detached from the blood's corpuscles to combat the poison; and that this antidote remains in the blood after the poison has been met and vanquished. Thus in order to cultivate the antidote we infect the blood with a mild dose of poison, and the blood in response prepares a quantity of antidote which will resist the onset of the poison if it should appear in large quantities. It is on this principle that we vaccinate as a preventive against smallpox; that we vaccinated with a sort of broth of typhoid bacteria, in order to preserve our soldiers in the South African war from enteric; that we prepare a serum in the veins of the horse as an antidote against diphtheria; or that we tried to find an antidote to the poison of the tubercle bacillus. Some of the processes by which immunity can be artificially secured from such treatment of the blood have been successes; some have been failures; and some, though believed by scientific authorities to have the germs of success in them, have excited profound public mistrust. In the case of one method, that of anti-typhoid vaccination, the distrust among soldiers and sailors was sufficiently manifest to make the Government abate the use of Professor Wright's vaccine, probably because they felt that its continued use might prejudice recruiting. That was a quite legitimate exercise of caution on the part of the Government; and they might also plead on behalf of their action (though Professor Wright has produced figures which strongly support his contention that the vaccine is efficacious) that bacteriologists are divided in opinion concerning the Wright vaccine. It is maintained by some that his method of sterilising the bacteria does not extract, as it were, the intra-cellular poison in efficacious proportions. But whatever may be the truth about this particular remedy, it is of the highest importance that the public should approach these new methods of treatment with understanding and without prejudice. Dr. Newman's book is not a text-book; and it does not treat this subject very fully. It rather presents conclusions than justifies them. We call attention to this particular brevity in the present edition because we should like to see it remedied in a future one, for we believe that there is hardly any question which, in the public interest, should be made more clear to them than the principles on which the bacteriological treatment of disease rests. But if in the one instance we have chosen Dr. Newman appears to err on the side of conciseness, we cannot refrain from expressing our highest admiration for the masterly digest he has made of the many subjects of the highest public importance which are bound up with bacteriology, and for the extremely able manner in which he has presented the very latest information and theories in respect of them. Among the subjects, as amply illustrated as summarised, are Bacteria in Air and Water, the Bacteriology of Sewage, Bacteria in Milk, Bacteria in Foods, Tropical Diseases, Tuberculosis Immunity, and Anti-toxins and Disinfection. The earlier chapters are a summary of bacterial biology and theory.

Birds of Russian Lapland, by Henry J. Pearson. Mr. Pearson is a most enthusiastic ornithologist, who has made the north of Europe for many seasons his hunting ground. His ardent search for the nesting places of birds has led him into many wild countries in northern regions. A few years ago some of these journeys and their results were described in "Beyond Petsora Eastward," and "Three Summers among the Birds of Russian Lapland" may be called a sequel to that volume. The work of three seasons included that of 1899, when the author visited the coast of Russian Lapland; that of 1901, when he voyaged to the Kanin Peninsula on the east side of the White Sea; and that of 1903, when the interior of Russian Lapland was visited. The book is arranged in the form of a diary; its contents will be especially valuable to those interested in the species of birds which nest in the north, many of which—such as fieldfares,

redwings, ducks, geese, and waders—are familiar visitors to England in winter. The last chapter of the book deals with history rather than natural history, and is devoted to St. Triphon, "the enlightener of the Laplanders," and the monastery founded by him on the Pechanga River in North-Western Russian Lapland. Mr. Pearson's work is profusely illustrated with reproductions of the author's beautiful photographs. There are 68 full-paged plates in all. Besides the many charming photographs of the birds and of nests and eggs, others illustrate most effectively the country and the people, and others the flora. Mr. Pearson is much to be congratulated on compiling so fine a record of his wanderings in these wild and barren, but fascinating, regions.

The Process Year Book for 1904-5 (Penrose and Co.; 4s.) comes out as a handsome volume, replete with hundreds of beautiful illustrations in all styles, of which 54 are in colour. This is the tenth year of issue, and it may well be supposed what an interesting exhibition it forms of the progress made in this art. To quote from the preface: "Ten years is a short period as history is made and measured, but it has been long enough for process workers to achieve a great deal. Few modern industries have progressed at such a rapid rate, and few have so rapidly and completely revolutionised or superseded older methods." A number of interesting articles by well-known experts in the various branches of process printing complete this valuable history.

Dyes and Stains and Polishes.—In "Dyes, Stains, Inks, Varnishes, Polishes, &c., including the art of Wood-staining, Filling, and French Polishing, Briefly, but Sufficiently and Clearly Explained" (Dawbarn and Ward), the author, Mr. Thomas Bolas, sufficiently and clearly, if not briefly, explains the contents and scope of his small sixpenny handbook. It is intended for the beginner, and it is terse and far from being overloaded with detail.

The Elements of Geometry, by Braithwaite Arnett (Simpkin, Marshall and Co.; price 2s. each part).—Geometry does not change much with the times, yet new books periodically appear to instruct us in the old science. In the three small volumes before us there is certainly some novelty. A good deal not usually included in such works is introduced. Trigonometrical ratios, comparative scales, points of the compass, even thermometer scales, are briefly but clearly gone into, and in the more minor details of bold and simple diagrams and large type a decided improvement on many older text books is effected. It almost seems a pity that more changes are not made. For instance, many definitions, which, though strictly according to custom, are in reality very useless in modern instruction. Take No. 16, "When a straight line is drawn between two given points which are its ends, it is called a finite straight line." It is *not*, in common parlance, called a "finite straight line," and if it was, that would surely be a sufficient description. So, also, it seems rather unnecessary to lay down that "a rectangle has all its angles right angles."

"**The Elements of Trigonometry**, by S. L. Loney (Cambridge University Press; price 3s. 6d.), may be criticized in much the same way as the foregoing. There is nothing exceptionally new in this small book, which is intended for the use of students commencing Trigonometry, but the subject is simply and clearly put, and heavy type introduced to emphasize special points.

"**Stories from Natural History**," by Richard Wagner. Translated from the German by G. S. (Macmillan; 1s. 6d.).—This is a most excellent little book for children, calculated to awaken their interest in animals and to encourage their powers of observation. Quite short accounts of different animals are simply given, and these are well illustrated from photographs.

How to Build a Bicycle, by Mr. R. H. S. Williams, and **How to Build a Petrol Motor**, by Mr. James F. Gill, B.Sc., are the titles of Nos. 4 and 3 of the "Home Worker's Series" (Dawbarn and Ward; 6d. net). They are simply written and practical handbooks, specially adapted for use by amateurs. "**Toning Bromide**," by Mr. R. E. Blake Smith, is the subject of No. 16 of the "Photography Bookshelf Series" (Iliffe and Sons). The author's name is familiar to photographers through the method of sulphide toning introduced by him. This method is dealt with in the present volume, and the author gives besides detailed descriptions of other methods of modifying the colour of bromide and other developed silver prints.

Astronomy.—The appearance of a third edition of the admirable and fascinating book by Mr. Walter E. Maunder, F.R.A.S., "Astronomy Without a Telescope" (W. Thacker and Co.) is interesting, not only as a tribute to its great and well-deserved popularity, but as proving the existence of a large and increasing number of persons who take an intelligent interest in the study of natural phenomena.

Astronomy for General Readers (Whittaker and Co.), by Mr. George F. Chambers, F.R.A.S., is re-published in a cheap edition at the price of one shilling, whereby a useful and readable book is brought within the means of the general reader of popular science.

Fireside Astronomy (Witherby and Co.; price 1s. 6d. net) by Mr. D. W. Horner, F.R.Met.Soc., M.B.A.A., is intended, as its title suggests, to meet the requirements of the intelligent amateur, who, having neither the time nor the means for a serious study of the subject, would yet be very glad to know in a general way something of the science of astronomy.

Examples in Arithmetic (George Bell and Sons; with or without answers, 3s.) is compiled by Mr. Charles Pendlebury, assisted by Mr. F. G. Robinson, from his "New School Arithmetic." The examples range from elementary to advanced arithmetic, Part II. including elementary mensuration and logarithms.

"**Hints on Collecting and Preserving Plants**" (West, Newman, and Co.; price 1s.), by Mr. Stanley Guiton, contains useful hints for the formation of a herbarium by a young collector, and gives advice respecting the best means of collecting, drying, preserving, and arranging plants.

"**The Hygiene of Bird-Keeping**," by Mr. W. G. Creswell, M.D., L.R.C.P., F.Z.S. (R. G. Clement; price 1s. net), consists largely of articles which have appeared in "Bird Notes." It gives practical and sensible hints on the housing and feeding of birds.

"**Christianity and Rationalism on Trial**" (Watts and Co.; price 6d.) is the title of articles by various authors contributed to the *Clarion* in the course of a controversy which took place in the pages of that journal on the subject suggested by the title.

"**Do We Believe**" (Watts and Co.; price 6d.), by Mr. John Allan Hedderwick, summarises a correspondence which took place on the subject of "Belief" in the columns of the *Daily Telegraph*, and attempts to show what, in the author's opinion, are the foundations of a stable belief.

"**Christianity and History**," by the Rev. J. Neville Figgis, and "**Britain and Her American Colonies**," by Mr. E. and S. Horsburgh (James Finch and Co.; 2s. net) are two of a series of small volumes published with an educational purpose. They are primarily intended as the subjects for essays or holiday tasks; and examination papers by the respective authors can be supplied to teachers at 5s. per 100 copies. The subjects dealt with are treated in a readable and popular style.

"**Italian Varnishes.**"—Mr. George Fry, F.L.S., F.C.S., believes himself to have solved the long-vexed problem of the varnishes used by the great Italian masters of violin-making. The results of his study and experiment are given in his book on "The Varnishes of the Italian Violin-Makers of the Sixteenth, Seventeenth, and Eighteenth Centuries, and their Influence on Tone" (Steevens and Sons; price 6s.). Hitherto experts who have had facilities for examining the varnishes on old Italian instruments have believed it to be an oil varnish coloured according to the fancy of its individual makers, and divers explanations have been offered to account for the inability of modern violin-makers to reproduce it. Mr. Fry suggests as the explanation of the problem that the old violin-makers used as the constituents of their varnishes the natural products of trees (conifers) and plants (flax) growing in their immediate vicinity; that they were simple varnishes composed of resin and turpentine, or of these two substances and linseed oil; and that the various apparent colours were due to optical effects naturally arising from variations in the details of the preparation of the varnishes. We can only say, without seeing and hearing the results of Mr. Fry's experiments, that the arguments used by him in support of his assertion, and his descriptions of the experiments made by him, are exceedingly interesting, and worthy of attention.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Fibrous Constituents of Paper.

PAPER is generally understood to be made from "rags." This is, however, only partially true, as papers may be considered to be roughly divided into two classes: white printing and writing papers, of which only certain of the writing papers have much rags in them; and coarse wrapping and bag papers, including brown papers, which are almost entirely innocent of rags. Of late years in particular a revolution has taken place in paper-making by the use of wood-pulp. Twenty years or so ago the use of wood was limited to what is known as "mechanical wood-pulp," short broken fibres torn from logs by means of some grinding apparatus, and it was considered impossible for satisfactory fibres with good "felting" properties to be obtained from so stiff and intractable a substance as wood. Then came the introduction of chemical wood-pulp, in which the logs of wood have been treated by the soda bisulphite or sulphate processes, the result being soft white fibres which are now more largely used in paper-making than any other material.

The testing of a sheet of paper is, in England, almost entirely a question of experience. Colour, feel, hardness, absorbent properties, strength, freedom from dirt, specks, and other imperfections—all these are decided by looking at and handling the paper only, and the buyer would probably be much puzzled if it were suggested that he should make a microscopical examination of the papers he had bought. The result is that there is in England no standard of comparison by reference to which disputes as to quality may be readily settled. In Germany, on the other hand, at Charlottenburg, there is a Government laboratory for the sole purpose of testing papers, not only those used by Government departments, but any others which may be submitted. This does not necessarily show, however, that such a laboratory is needed here, for whilst a more uniform set of standards might be of service, the requirements of various papers vary so greatly that rigid, inelastic tests may easily be very misleading.

The microscopical examination of paper, however, limited, as it generally is, to the ascertaining of the fibres of which the paper is made, has no such disadvantages other than those due to the necessity for training and experience in such a matter, and it is a matter of surprise that this branch of paper-testing has not received more attention in this country. It may be of interest to many of the readers of these columns if I endeavour briefly to explain the methods of recognition of the various fibres, avoiding as far as I can all technicalities.

(*To be continued.*)

Royal Microscopical Society.

At a meeting held on December 21 at 20, Hanover Square, Mr. G. C. Karop in the chair, Mr. Conrady read a short paper explaining an experiment he exhibited to prove the phase-reversal in the second spectrum from a grating of broad slits, the mathematical proof of which was given in his paper on "Theories of Microscopical Vision," read before the Society at its last meeting. The object consisted of two gratings, one above the other, similar in every respect except that one had broad and the other narrow slits. In accordance with what was theoretically predicted by the author, the difference was brought out when the direct light *plus* the first and second spectra of *one side* were admitted, but when the direct light was cut off by the movement of a shutter the image of the *broad slits* underwent a startling change. The lines jumped across to positions midway between the correct ones, showing there was an antagonism of phase between the light of the first and that of the second spectrum. Some photographs were exhibited by Mr. Rheinberg which showed the effects produced by cutting out the various spectra of one side, and he suggested to Mr. Conrady that the experiment should be made to test the correctness of the theory. Mr. J. W. Gordon then gave a summary of his paper "On the Theory of Highly Magnified Images," and illustrated his remarks by numerous diagrams shown on the screen. A discussion ensued in which Messrs. Rheinberg, Beck, and Conrady took part, and Mr. Gordon briefly replied.

The Quekett Microscopical Club.

The 418th ordinary meeting of the Club was held on December 16 at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. After the ballot had been taken for the new members, the President announced that fifty members had been elected during the past year, and congratulated the Club upon the increase, which he hoped would be fully maintained in the future.

Mr. C. G. Curties, F.R.M.S., exhibited and described the new Nernst electric lamp arranged for use with the microscope, and also one of Baker's "Diagnostic" microscopes, a model combining extreme portability with firmness.

Mr. D. J. Scourfield, F.R.M.S., gave an interesting lecture on "Fresh Water Biological Stations," illustrated by lantern views of the exterior and interior of the principal fresh water biological stations in Europe and America. He pointed out that they had their origin in the general deepening of biological research which followed the establishment of the Naples and other marine biological stations, between the years 1870-1890, aided by the rise of Limnology, which in itself was largely due to Professor F. A. Forel, who had shown by his work on Lake Geneva what might be done by a systematic study of lakes. The first fresh water biological station in England was started in 1902 at Sutton Broad, Norfolk, by Mr. Eustace Gurney, and although the station was as yet but little known, it had already been the centre of good work, and deserved every encouragement.

Improved Methods of Working with the Vertical Illuminator.

I am indebted to a correspondent for the following methods of using the vertical illuminator:—

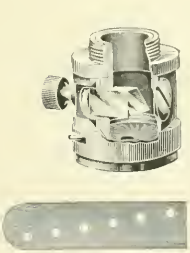
Method I.—With the image of a stop. Method II.—With the stop and the vertical illuminator.

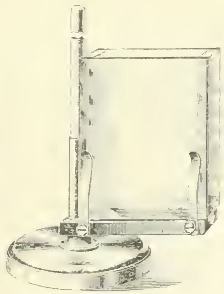
The accessories necessary for Method I. are (1) source of light; (2) carrier for stop; (3) condenser; (4) vertical illuminator. The condenser is first set between the light and the vertical illuminator, so that it forms an aërial image of the source of light at a distance from the vertical illuminator equal to that from the vertical illuminator to the top of the eye-piece. The carrier for the stop is then placed between the light and the condenser in such a position that its aërial image is exactly adjusted and falls sharply in focus at the back lens of the objective. This will give an effect precisely the same as placing a stop or diaphragm over the vertical illuminator itself, while the upward path of the rays from the object to the eye is unimpeded.

The accessories necessary for Method II. are (1) source of light; (2) bull's-eye condenser; (3) vertical illuminator with stop or diaphragm fitted *to its side*. For this method, the lamp and bull's-eye are adjusted as in Method I., care being taken that proper distances are kept, when the same effect will be produced as with a stop or diaphragm placed immediately over the vertical illuminator.

New Vertical Illuminator and New Monochromatic Trough.

Messrs. R. and J. Beck, Ltd., have brought out a new vertical illuminator of the prism type fitted with an iris diaphragm beneath the prism for cutting off outside light, and a plate of stops so arranged that the position of the beam of light impinging on the prism can be varied until parallel light of the right angle is obtained. The vertical illuminator is largely used now to illuminate the surface of metals when making metallurgical examinations with the microscope. The principle is that a beam of light sent at right angles to the optic axis of the microscope is reflected by a prism





or piece of cover-glass down upon the object so that each objective acts as its own condenser. It is probably the only means of illuminating objects mounted dry when they are examined with immersion lenses, though in this case it is necessary that the object should be in actual contact with the cover-glass.

The trough is noticeable for its compactness and easy adjustability. It can be brought as low as one inch from the table or raised to a height of nine inches. The fluid used in the cell depends upon the required colour of the light.

Notes and Queries.

Examination of Water.

John Carrington, East London, S.A.—I do not think you would find anything in town-water unless it was very bad. Under any circumstances a Botterill's trough would not do, as the thickness of the glass and the depth of the cell would prevent your using a high enough power. I would suggest your getting a sample of water from a stagnant pond or old tub, taking up a few drops with a glass tube, and by examining it in an ordinary excavated cell, covered with a thin cover-glass, you will find enough to interest you there. The weird animal life exhibited sometimes in a drop of water at lectures has, I am afraid, been specially selected to astonish the audience.

Deane's Medium.

Mr. T. H. Russell, of Birmingham, would be glad to know if any reader of these columns has had any experience of Deane's medium for mounting vegetable specimens for the microscope. He says he has been in the habit of mounting his mosses in glycerine jelly, but, like most people who use it, has found it somewhat treacherous. He has found Deane's medium more reliable in some ways, but it has a tendency to shrivel up certain specimens—*e.g.*, some large-celled mosses—directly they are immersed in it. He tried boiling them first in a little dilute glycerine and water, also adding a little water to the medium, but without improvement. He would be glad of suggestions as to the cause of this, or a formula for making the medium other than that given in Davies' book on "Mounting Microscopic Objects." I do not think I have ever used this medium myself. Can any reader make any suggestions?

Naming Specimens.

H. W. V., Birmingham.—I am anxious to help my readers as much as possible, but I do not think you quite realise how much work is involved in naming specimens. Microscopy covers so wide a field that it is impossible for one man to have the minute specialized knowledge necessary for identifying specimens in the whole field of Nature, and I have therefore to get my friends in Cambridge and elsewhere to assist me in such matters. For instance, I would rather not name specimens of either fungi or mosses, and I hesitate to hand them over to specialists unless I am quite sure that they are more or less uncommon species which have an unusual interest to some correspondent who is working specially on them. If this be so in your case I will do what I can for you, but I trust you will forgive this public reference, because I receive so many requests to name specimens that I have thought some little explanation may be of service. On purely microscopical matters I am glad always to do what I can, however elementary the questions.

Observation of Flagellæ and Cilia.

J. W. Brown, Inverkeithing.—The $\frac{1}{6}$-inch objective you mention is an excellent one, but flagellæ and cilia are generally most difficult to see, especially if the animal is alive. Your best plan will be to add a little cocaine to the water and watch till the movement begins to slow down, when you may be more successful. I do not think a more costly lens would be of any greater service to you, but you are not giving either yourself or your objective a fair chance if you have not got a sub-stage condenser. The improvements in modern high-power objectives are almost nullified without a condenser. Could you not extemporise a ring that would enable you to use a 2-inch or 1-inch objective as a condenser? You will find, however, that the absence of an iris diaphragm to adjust the light is yet another drawback, as cilia will not bear a large cone, being so lacking in contrast. You cannot get good dark-ground illumination with lenses of higher aperture than about ·6 N.A., in fact you will probably find any objective higher than a half-inch does not give good annular illumination. The spot must be proportioned to the aperture of the objective, the larger the angle (that is, generally, the higher the power) the bigger must be the spot.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.41, and sets at 4.47; on the 28th he rises at 6.50, and sets at 5.36. The Sun is after the clock, the equation of time being approximately 14 mins. throughout the month.

For plotting the positions of spots, with respect to the axis and equator, the following table may be used:—

Date.	Axis inclined from N point	Equator N. of Centre of disc.
Feb 5 ..	13° 55′ W.	6 21′
" 15 ..	17° 35′ W.	6° 54′
" 25 ..	20 40 W.	7° 11′

THE MOON:—

Date.	Phases.	H. M.
Feb. 4 ..	● New Moon	11 [illegible] a.m.
" 12 ..	☽ First Quarter	4 20 p.m.
" 19 ..	○ Full Moon	6 52 p.m.
" 26 ..	☾ Last Quarter	10 4 a.m.
Feb. 8 ..	Apogee	7 48 p.m.
" 20 ..	Perigee	11 36 p.m.

A partial eclipse of the Moon takes place on February 19. In this country the Moon rises about half an hour before first contact with the shadow.

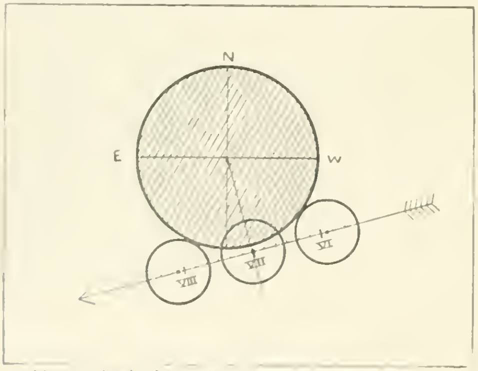


Diagram showing Path of Moon through the Earth's Shadow.

Further particulars are as follows:—

First contact with Penumbra	Feb. 19	4.41	p.m.
" " " Shadow	" "	5.54	"
Middle of Eclipse	" "	7.0	"
Last contact with Shadow	" "	8.7	"
" " " Penumbra	" "	9.19	"

Magnitude of Eclipse 0·410 (Moon's Diam. = 1.)

Moon rises at Greenwich, 5.16 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich at convenient times.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. point.	Angle from Vertex.
Feb. [illegible]	θ¹ Tau[illegible]	[illegible]	[illegible] 2	[illegible]	[illegible]	6 [illegible]	[illegible]	2[illegible]9
" 1[illegible]	θ² Ta[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2[illegible]	2[illegible]
1[illegible]	B.A.C. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible] T[illegible]	[illegible]	[illegible]7	[illegible]	[illegible]	[illegible]	[illegible]	21[illegible]
21	η Vir[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

THE PLANETS.—Mercury is a morning star, rising about an hour before the Sun for a few days early in the month; later, he is in too close proximity with the Sun to be observable.

Venus is now the most brilliant object in the evening sky, looking S.W. The planet is at greatest elongation of 46 41′ E. on the 14th, setting about 9.10 p.m. on the 1st and at 10.5 p.m. on the 28th. About the middle of the month the apparent diameter of the planet is 25″, whilst the phase is "half moon," 0·516 of the disc being illuminated; her lustre, however, is increasing, as the point of maximum brilliancy is not attained until near the end of next month. Throughout the month the planet souths about 3 p.m. on each day, and is easy to discern about this time even with the naked eye; the meridian altitude increases from 38 on the 1st to 51 on the 28th. The Moon is near the planet on the evening of the 8th, being 3 20′ S. of Venus.

Mars does not rise until after midnight.

Jupiter is diminishing somewhat in brightness, and getting more to the west, and sets about 10.45 p.m. near the middle of the month; he is, however, very conveniently situated for observation in the early evening. The equatorial diameter of the planet is 37″·3 on the 13th, whilst the polar diameter is 2″·4 smaller. The satellite phenomena visible in this country are as follows:—

Date.	Satellite.	Phenomenon.	P.M. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.
Feb				Feb.				Feb			
1	II.	Tr. I.	6 50	11	III	Sh I.	6 42	19	II.	Sh. E.	6 28
	II	Tr E.	9 23		III	Sh E	8 28	20	I.	Tr I.	8 30
	II	Sh. I.	9 26	12	I.	Oc D	9 22		I.	Sh I	9 38
3	II	Ec. R	6 1	13	I	Tr I.	6 31	21	I.	Ec R	9 8
4	I	Tr. I.	10 1		I	Sh. I.	7 42	22	I.	Sh. E.	6 19
5	I.	Oc D.	7 23		I.	Tr. E.	8 44	24	II.	Oc. D.	9 17
	I.	Tr. E	6 45		I.	Sh E.	9 55	26	II.	Sh. I	6 36
	I.	Sh E	7 59	14	I	Ec R	7 13		II.	Tr E	7 2
8	II	Tr I.	9 35	17	II.	Oc. D.	6 29		II.	Sh E	9 5
10	II	Ec R	8 39	18	III.	Tr E	8 9	28	I.	Oc. D	7 52

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is no longer observable, being in conjunction with the Sun on the 12th.

Uranus is unobservable.

Neptune is on the meridian about 8.45 p.m. on the 14th; he is describing a short retrograde path in Gemini, and can be found by reference to the star μ Geminorum.

	Right Ascension.		Declination.
Neptune (Feb. 14).	$6^h\ 24^m\ 17$	..	N. 22 19′ 18″
μ Geminorum . .	$6^h\ 17^m\ 13^s$	..	N. 22 33′ 37″

METEOR SHOWERS:

Date	Radiant. R A	Radiant. Dec	Near to	Characteristics
Feb. 5 10	75	+41	η Aurigæ	Slow; bright.
" 15	231	+11	α Serpentis	Swift, streaks
" 20	181	+34	Cor Caroli	Swift, bright

VARIABLE STARS.—Algol may be observed at minimum on the 5th at 9.8 p.m., 8th at 5.57 p.m., 25th at 10.51 p.m., and 28th at 7.40 p.m.

ο Ceti (Mira) is due at a maximum on 25th February; its period, however, is somewhat irregular.

Knowledge & Scientific News

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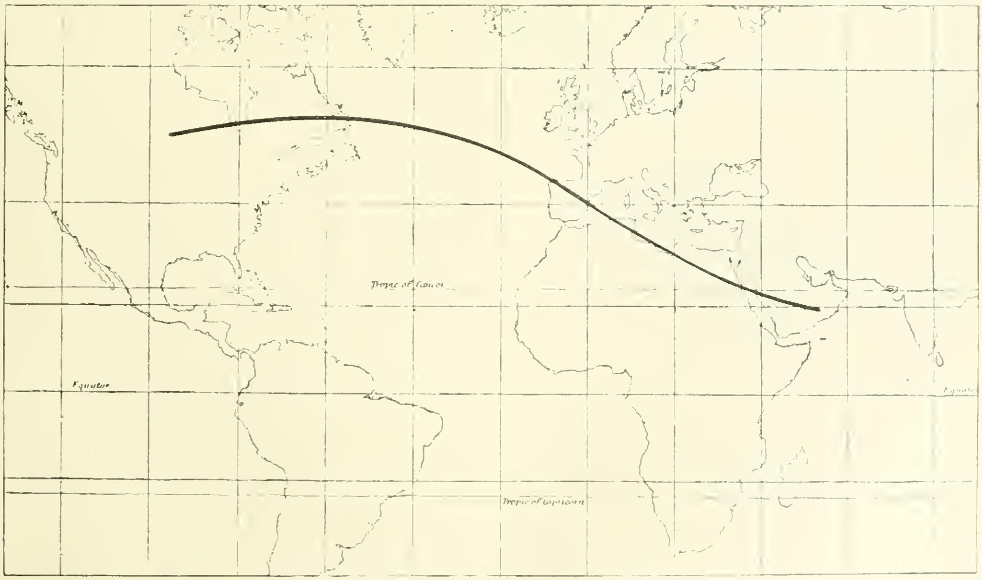
CONTENTS.—See Page VII.

The Coming Total Eclipse.

By W. SHACKLETON, F.R.A.S.

THE extreme importance of making exhaustive observations during the total eclipse of the sun on August 30, 1905, is evident when we review the progress of astrophysics during the past decade, and bear in mind that the sun is the only star which can be examined in geometrical detail, whilst only the integrated effect of every other star can be studied. The elucidation of many stellar problems depend almost in their entirety on a more perfect understanding of the conditions existing on the sun. To give an example, the star γ Cygni presents a spectrum which, although akin to the Fraunhofer spectrum, differs markedly in detail, yet the outlying portions of the sun give, in the "flash," a spectrum bearing a close resemblance to that of the star. Again, the urgent need of making every preparation to collect useful data is apparent on looking into the future to see what opportunities will be available during another solar cycle for observations of our fiducial star under these special conditions. Enumerated below are the total eclipses of the sun during the next eleven years, with the locations of the shadow paths.

Date.	Duration.	Where visible.
1907—Jan. 14	2 mins.	Ural Mountains, Central Asia, China
1908—Jan. 3	4 ,,	Pacific Ocean; ends Isthmus of Panama
1908—Dec. 23	—	South Atlantic. (Annular eclipse, forming into a "Total" of short duration)
1909—June 17	1 ,,	Greenland, Arctic Regions, N. Siberia
1910—May 9	4 ,,	Antarctic Ocean, passes over Tasmania near end of eclipse
1911—April 28	5 ,,	Australasia, Pacific Ocean
1912—April 17	0·1 ,,	Spain. (Annular eclipse, forming into a "Total" of short duration)
1912—Oct. 10	1 ,,	Venezuela, Brazil, S. Atlantic
1914—Aug. 21	2 ,,	Greenland, Norway, Sweden, Russia, Persia
1916—Feb. 3	2 ,,	Pacific, Panama, Colombia, Venezuela, Atlantic, Azores



Path of Shadow. Eclipse, 1905, August 30.

The total eclipse of the sun during the present year on August 30 possesses many advantages, in that it is almost at our own doors, is of long duration, and the most accessible for many years to come.

The shadow strikes the earth in Canada south-west of Hudson's Bay, where the eclipse begins at sunrise; it then leaves the American Continent near Domino Harbour, Labrador, crosses the Atlantic, and reaches Europe near C. Ortegal, in the N.W. of Spain, traverses over Spain, near Oviedo, Palencia, Burgos, Ateca, Calatayud, Castellon, thence across the Mediterranean to Algeria, Tunis, Tripoli, Egypt (near Assouan), and finally to Arabia, where the sun will be eclipsed at sunset. The width of the shadow varies slightly at different portions of the track, but it is, approximately, 120 miles.

Further particulars are as follows:—

—	Local Time. Beginning of Totality.	Duration.	Sun's Altitude.
		m. s.	
Domino Harbour	5.11 a.m.	2 35	27°
Oviedo ..	12.38 p.m. (noon)	3 40	56°
Palencia ..	12.4[illegible] p.m	3 3[illegible]	56
Burgos ..	12.[illegible]1 p.m.	3 35	56°
Ateca ..	1.4 p.m.	3 40	56
Calatayud ..	1 4 p m	3 40	56
Castellon	1.21 p.m	3 30	55
Assouan (near)	4 36 p m	2 33	24

On account of its proximity, Spain will be largely favoured as a site for making observations, and, in addition to parties from this country, further contingents may be expected from America. Burgos, already visited by some members of the British Astronomical Association after the eclipse of 1900, is of easy access, being served by the direct Paris Madrid rail, and can be reached from London in 32 hours, whilst Palencia can be reached almost as quickly, and has the advantage of being described as "healthy and cold." In consequence of the meagre accommodation (the greater part of which is already engaged at Burgos), a prolonged stay is undesirable, but San Sebastian or Biarritz may serve as a base for the former, and Santander for the latter place.

Spain, showing Central Eclipse Line, with North and South Limits.

Oviedo can be reached from Palencia in about $7\frac{1}{2}$ hours, and is one of the few places in Spain with hotels described as "good."

Ateca and Calatayud are more difficult of access, as a journey to Madrid or Saragossa is involved, thence by the Madrid and Saragossa line.

The disadvantage of the Mediterranean coast is the great heat at this period of the year, but more favourable weather conditions are to be expected the further eastwards one proceeds. Castellon is one of the most promising places and can be reached from Valencia in less than two hours, or from Barcelona in six hours, whilst the journey from London to Barcelona can be made in thirty hours, or quicker than to Madrid.

A skeleton itinerary, with times of trains now in

operation to some of the above places, will give some indication of the time one should allow.

Burgos and Palencia.			Ateca and Calatayud.		
London,	2.20 p.m.		London,	9.0 p.m.	
Paris,	10.7 p.m.	h. m.	Paris,	5 50 a.m.	
Paris,	10.36 p.m.	31 46	Paris,	12 18 p.m	
Burgos,	9 33 p.m.		Madrid,	2.25 p.m.	h. m
Venta de Baños,	11.15 p.m.		Madrid,	2.50 p.m.	56 50
Venta de Baños,	1.46 a.m.		Ateca,	4.20 a.m.	
Palencia,	2.1 a.m.		Calatayud,	4.50 a.m.	
Santander,	—		Saragossa,	—	
London to Barcelona (*via* Lyons)		$29\frac{3}{4}$ hrs.	Barcelona to Castellon (*via* Tarragona)		$6\frac{1}{4}$ hrs.

The work to be attempted at any of the stations named has to be done in about $3\frac{1}{2}$ minutes, hence to obtain useful results one should have a knowledge of some of the problems requiring further investigation or of new points to be attacked and arrange a programme accordingly.

The aim of all eclipse expeditions is to study those parts of the sun which are visible only during a total eclipse, in order to gain a further insight into the physical condition of the sun as a whole, and ultimately to bring this knowledge to bear on other cosmical bodies in general. The most obvious feature of a total eclipse is, of course, the Corona, and although it has been so repeatedly assailed, deeper and more perplexing problems have arisen in proportion to the assaults, and Professor Campbell concludes that "it is as enigmatical as ever."

Some of the more interesting points regarding the Corona are:—

Its visibility, photographically or visually, in the partial phases of the eclipse.

The extension of the coronal rays.

The differentiation of the part which shines mostly by reflected light from that which is self-luminous.

Its spectrum.

Other points, such as its connection with prominences, dark rifts, detailed structure, photometric value at varying distances from the Moon, rotation, brightness and wave lengths of its spectrum lines, cannot be fully considered in an article of this length.

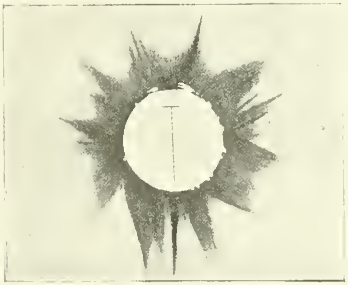
Small cameras can with advantage be employed in the solution of the first three points, but to meet with any measure of success the lens ratio of aperture to focal length requires to be large, partly in order that the exposure may be short enough to neglect equatorial following which will be unprovided for in the majority of cases with this class of instrument.

The most notable result as to coronal extension is the photograph obtained by Mrs. Maunder at the eclipse of 1898, with a lens ratio of $f/6$ exposing 20 seconds on a triple-coated Sandell plate, but as the conditions of the coming eclipse are different and the sun is approaching a maximum, long rays may not exist, or if present be no brighter than the sky background. However, it is in this direction that one must look for the recording of rays to the extent that the naked eye is able to perceive them. For prominences and the recording of detail of the lower parts of the Corona, a lens of long focal length, slow plates, and exposures of half a second or less are preferable, but as the scale of ordinary cameras is small, such records are best obtained with larger instruments, as the every-day camera is more profitably employed on other work.

Photographs should be taken several minutes before and after totality to ascertain when the Moon's limb can be discerned beyond the arc shown on the solar disc; when this point arrives it is evident we are seeing the Moon projected on the Corona as a background. It would be desirable to prevent the direct image of the crescent sun falling on the plate, but as this is varying, it is scarcely possible, except with a large image and clock movement, though one might try the effect of a screen such as is used in cloud photography, one of a greenish hue being preferable.

Such photographs will furnish useful data to determine the feasibility of observations of the Corona in annular eclipses or even without an eclipse.

In consequence of the varying brightness of the Corona at different distances from the sun's centre, it has usually been found necessary to compile a composite picture from many negatives to exhibit the detail of the coronal extensions from the sun's limb to their extremities, since any one exposure will only be correct for a particular brightness, some parts being over and others under-exposed. Now, the type of Corona to be expected is that usually shown at the maximum sun-spot period, and will in all probability be similar to those of 1882 and



Corona, 1893.

1893; Professor Turner has shown that in the case of the latter the law of luminosity of the Corona was:

$$\text{Brightness} \quad \text{varies as} \quad \left(\begin{array}{c}\text{distance from}\\ \text{sun's } \textit{centre}\end{array}\right)^{-6}$$

He has shown also that the same law represents the luminosity of the 1898 Corona, and probably it approaches near the truth for all the various types of Coronas, and is more satisfactory than that formulated by Professor Harkness in 1878, who gave the brightness varying simply as the inverse square from the *limb*, for if the Corona be largely made up of minute particles, other inverse powers of the distance in addition to the ordinary inverse square law of luminosity will enter into the equation.

Hence to obtain photographs of the Corona with the exposure correct for every part, it will be necessary to adopt a method similar to that employed by Buckhalter, and use a rotating disc immediately in front of the plate on which the image falls, with a templet cut out to give the exposure in accordance with the above law.

(*To be Continued.*)

Exhibition of Meteorological Instruments.

The Council of the Royal Meteorological Society have arranged to hold, by permission of the President and Council of the Institution of Civil Engineers, at their house in Great George Street, Westminster, an exhibition of meteorological instruments from March 14 to 17 next. The exhibition will be chiefly devoted to recording instruments; but will also include new meteorological apparatus invented or first constructed since the Society's last exhibition, as well as photographs, drawings, and other objects possessing meteorological interest, or instruments of very early origin.

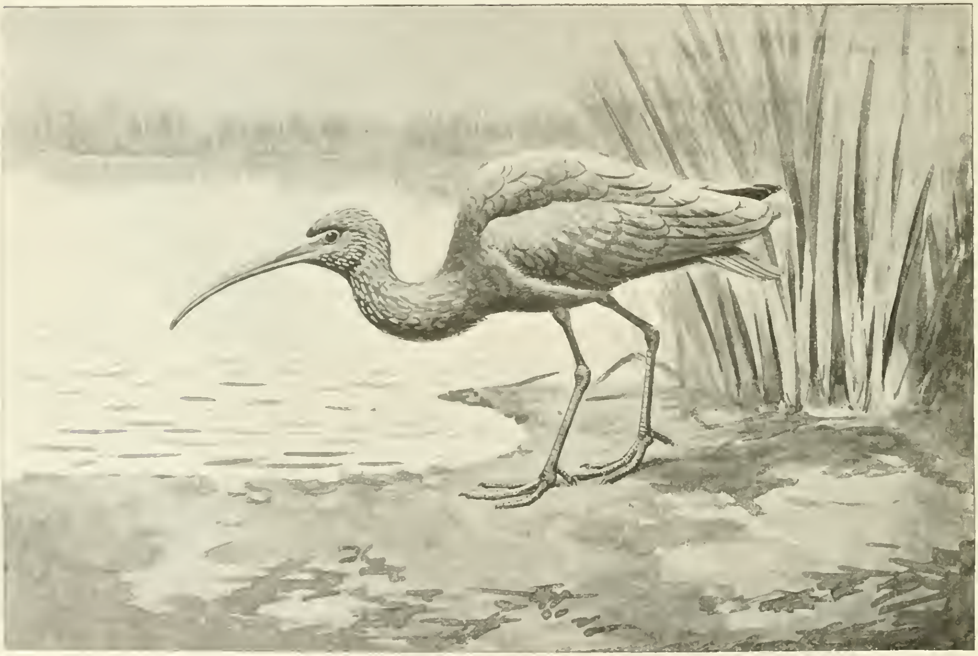
Rare Living Animals in London.

By P. L. SCLATER, D.Sc., F.R.S.

IV.—The Glossy Ibis.

THAT the "Glossy Ibis," formerly known to the gunners of the Eastern counties as the "Black Curlew," was much more abundant in the fens of Norfolk and Cambridgeshire in past years is certain, but whether it was ever a regular breeding inhabitant of those districts does not seem to have been clearly made out. In these days, however, the Glossy Ibis can only be classed as a not very infrequent straggler to the British Islands, mostly occurring in the eastern and southern counties. But it is a bird of wide range, being found in suitable localities all over Africa, Southern Asia, the Moluccas, and as far off as Eastern Australia, where it has lately been ascertained to nest more or less frequently.

In Europe the principal strongholds of the Glossy Ibis are in the marshes of the Lower Danube, and the swamps of the Guadalquivir, in Southern Spain, in both of which localities it breeds in large communities in company with other water-birds. In the former district, near Belgrade, and extending into the valleys of the Theiss and the Save is an endless plain, covered with forests of reeds, which is a perfect paradise for fish-eating birds of all sorts. It is full of rivers and lakes, flooded meadows, and half-submerged forests of willows and alders, a combination well calculated to make bird-life easy, and secure from man's intrusion. In 1883 this district was visited by Mr. W. Eagle Clarke and a party of Ornithologists, who subsequently published an excellent account of their excursion in "The Ibis." In a breeding station on the Save they found an enormous colony of Herons of different species, Pigmy Cormorants, Spoonbills, and Glossy Ibises engaged in making their nests in the bushes amongst the reeds, and forming a most attractive spectacle. Similar accounts are given by those who have visited the breeding haunts of this bird on the Guadalquivir, in Southern Spain, in the more sequestered lakes of India and Ceylon, and even as far off as in Eastern Australia, where, as we are informed by Mr. A. J. Campbell, in his volume on the "Nests and Eggs of Australian Birds," the Glossy Ibis was first detected breeding in 1889. This Ibis is also found in the southern States of North America, but in South America it appears to be replaced by a closely-allied form, the White-faced Ibis, distinguished by a narrow white line on the front of the beak.



The Glossy Ibis.

In the Zoological Society's Gardens the Glossy Ibis was formerly quite a rare bird, the first record of its presence there having been made in 1866. But in January, 1893, the Society purchased from a dealer seven young specimens of the closely-allied White-faced Ibis imported from Argentina, which at that time could not be distinguished from examples of the Glossy Ibis of the same age. These were placed in the Great Aviary, where they did well. In August of the same year they were joined by twelve specimens of the European Glossy Ibis, presented by the late Lord Lilford, who had received them along with other water-

birds from his correspondents at Seville. The South American and European cousins made friends at once, and formed a united flock, amongst which it was hardly possible to discriminate the two species, so much alike are they except in the height of the breeding season.

In the spring of 1895 the Ibises showed signs of breeding, and were to be seen carrying about sticks in their beaks. Many pairs were soon formed, without regard as to both sexes belonging to the same variety. The nests were placed on the summits of the stunted trees in the Great Aviary, formed of sticks, straw, moss, and other materials supplied to the birds by the keepers. The first brood of three young ones was hatched on June 19th of that year. Since that period the same process has been repeated every season, and though there have been many accidents and misadventures to these birds, which have a difficult task to hold their own amongst so many evilly-disposed neighbours, the flock of Glossy Ibises still exists, and the birds go on breeding, with more or less success, every year. It is impossible to tell the exact parentage of the different birds now in the Society's Gardens, but the greater number of them are probably hybrids between *Plegadis falcinellus* of Europe and *P. guarauna* of Argentina.

A new consignment of the European species has lately arrived, which, when the breeding-season of 1905 comes on, will, no doubt, give fresh vigour to this most interesting family.

Heredity.

By J. C. SHENSTONE, F.L.S.

II.

SPRENGEL, in his great work, led to the knowledge that forms of flowers exist solely for the purpose of securing the fertilisation of the seed. Those flowers which are inconspicuous and do not attract insects by their perfume or by their honey, as for instance most of the grasses, discharge clouds of pollen into the air, which is conveyed by the wind to other plants; but in the majority of cases flowers are specially constructed to attract insects in search of honey and of this pollen, as the yellow dust is now called. In their search they convey portions of the pollen from flower to flower, and thus the seeds of one plant are usually fertilised by pollen conveyed from another. Sprengel did not realise the full importance of the cross-fertilisation thus secured, but no botanist now doubts that cross-fertilisation is a profound necessity, and that the innumerable forms of flowers and their brilliant colours are due to their being constructed to attract the attention of insects. Sprengel, like many other great men, was born too soon.

Darwin's great work in establishing the theory of Evolution, and in demonstrating that we owe the innumerable forms of animal and vegetable life to a process of development, and to a process of "natural selection"—those individuals least suited to their environment disappearing as the result of the fierce competition constantly proceeding in nature—is too well known to need repetition here, but I should explain that whilst Chas. Darwin was elaborating his theory, and immediately afterwards, a mass of work was done by others which contributed to place the new development of knowledge upon a sure foundation. Not least among those who helped in this work was Nageli, who attacked the problems of life from quite a different direction, bringing a considerable training in physical enquiry to bear upon the study of the development of plants by the aid of the microscope.

If a very thin slice of the pith from a young shoot of elder be examined under the microscope, it will be seen to consist of a number of small bladders known to botanists as cells. When a cell is subjected to a temperature of 122 F. its contents shrink away from the outer skin, and can be discovered to consist mainly of a viscid granular substance. Nageli showed that this was true of the cells of the most lowly as well as the most highly developed plant and animal, for both of these are entirely composed of such bodies, and that everything living has grown from a single cell by a process of division, each cell becoming divided into two or more perfect cells, which are seen to divide again and again during the life of the tissue. Nageli also enriched the theory of evolution, as afterwards acknowledged by Chas. Darwin, by establishing the fact that there exist laws of variation in living things, which lead to their perfection, and also to their variation independently of the changes brought about by the struggle for existence. Thus at the end of the last century it was admitted that the essential basis of animal and vegetable life lies in the granular substance contained within the cell; that each animal and each plant is developed from a single cell now called the *germ-cell*; and that whilst the chemical and physical forces acting in living things are indistinguishable from the same forces when acting in dead matter, there exist indications of yet other laws of variation which lead to the perfection of living forms and to their differentiation. Finally, that the innumerable forms of plants and animals existing to-day are the outcome of natural selection; that these are due to the survival of those most suited to the changing conditions of life, and to the destruction of forms less able to hold their own in the struggle for existence.*

We are all familiar with the stages through which some members of the animal kingdom, *e.g.*, butterflies and moths, pass during their development into the perfect form. A caterpillar is hatched from an egg, this in due course is transformed into a chrysalis, from which the perfect butterfly or moth emerges, and the frog passes through the tadpole stage before arriving at complete development. Some classes of plants pass through similar stages, and it is held by most naturalists that the history of each individual recapitulates the history of its ancestry, and that if we traced the development of an animal or a plant from a single cell, or minute viscid body from which each individual is developed, we should discover the leading features of its ancestry.

After Darwin's theory had secured the support of men of science, Weismann impressed upon us the importance of the fact that all the characters, including the most minute peculiarity of bodily structure or mental disposition, must be transmitted from genera-

*It is contended by some botanists that species may have come into existence suddenly. The variations in both plants and animals, popularly known as sports, are known to all observers of nature. The variety of clover with four leaflets instead of three, and human beings with an abnormal number of fingers or toes, serve as examples. It is contended that such variations, called by biologists mutations or discontinuous variations, may have given rise to new species. Gardeners and breeders of animals have taken advantage of such variations for producing cultivated varieties, but no variety obtained in this manner has so far proved capable of holding its own in its wild state.

tion to generation through the viscid contents of the germ-cells. Not only has this minute body concentrated within it the power of reproducing all the anatomical details, but it must also transmit the peculiar difference of temperament of animals, which has given to the cat and dog, for example, a disposition to scratch and bite one another from time immemorable. This conception of the germ-cell would lead us to regard all animal and vegetable life as, in a sense, immortal; for as every living thing contains within it the power of producing this germ-cell, which in its turn has the power of developing all the mental and anatomical characters of the individual from which it is derived, it may be argued that each living thing contains within it the possibility of immortality.

The next contribution to our modern views upon heredity was made by Francis Galton. It is clear that animals and plants all receive contributions towards the characters they inherit, not only from their two parents, but also from their four grand-parents, their eight great-grand-parents, and in fact any ancestor may contribute characters down through a long line of descendants, and hence that each individual living thing must have inherited its characters from many millions of ancestors. As the number of ancestors becomes doubled in each generation through which we carry our enquiry, a simple calculation will demonstrate the large number of ancestors from which the individual has descended. In ten generations the number exceeds two thousand, provided that there has been no inter-marrying, and these figures increase more rapidly the further back we carry our calculations. It is obvious that only a portion of any individual ancestor could be transmitted. Thus if one parent has dark hair and the other flaxen hair, the child could not have both flaxen hair and dark hair; he must inherit either flaxen hair from one parent or dark hair from the other parent, or he must inherit an intermediate shade, receiving contributions from both parents. The child of a very tall father and a very short mother will either be tall, short, or of some intermediate height; he could not possibly inherit the characters of both parents in this respect. When we realise the vast number of ancestors from each of whom individuals may inherit characters, of those contributed by all the rest, we see how complicated the subject of heredity becomes. But the actual contributions from ancestors seem to diminish as we go backwards, for the contributions of the two parents, one would suppose, must equal those of the four grand-parents, of the eight great-grand-parents, and so on, since all the contributions combine into one individual. It is therefore convenient to confine the enquiry to the few later generations from which most of the characters have been received. Galton has endeavoured to do this and to construct a law of heredity upon these considerations. For this purpose he supposes that each individual receives half his characters from his two parents, one quarter from his four grand-parents, and one-eighth from his more remote ancestors. This assumption has received some support from materials found in the stock of the Basset hounds, started some years previously by Sir Everett Millais.

Galton's hypothesis refers more particularly to these characters which blend in the offspring. There are, however, many characters which will not blend. The coat colour of horses affords a good example of these. One seldom sees horses whose coat colour cannot be referred to one of the colours known as bay, chestnut, grey, and so on; the eye colour in man affords another example; we see brown eyes, blue eyes, hazel eyes, etc., but we seldom see tints which cannot at once be referred to some one or other well defined tints. When the eye colour of the two parents differs in tint, the child is stated to inherit this character from one parent only, or from some one more remote ancestor. A remarkable series of experiments, published in 1865, by Gregor Mendel, dealing more particularly with these characters which do not blend in the offspring, have lately been the subject of much animated discussion.

Gregor Johann Mendel, born in Odran, in Austrian Silesia, was the son of well-to-do peasants. In 1847 he was ordained priest, he studied physics and natural science in Vienna, and returning to the cloister became a teacher in the realschule at Brun. The importance of his experiments, which were carried out in the garden of his convent, were quite overlooked until recently, when they were simultaneously rediscovered by several investigators. The circumstances connected with Mendel's researches appear to be peculiarly like those of Sprengel's discovery of the fertilisation of plants by the aid of insects, except that, fortunately, Mendel does not appear to have allowed his enthusiasm for science to interfere with his duties to his Church. Professor de Vries called attention to Mendel's remarkable memoir in 1890, and Mendel's observations have since been confirmed by other workers.

These investigations consisted in experiments made by crossing varieties of plants differing from one another in some important pair of characters, and resulted in progeny being obtained which inherited those characters according to fixed numerical rules; thus Mendel's experiments give us ground for hoping to discover the laws which control the forces of heredity. He made a large number of experiments on the garden peas, selecting varieties having pairs of characters suited to his purpose. If the reader will observe the seed-peas sold at seed-shops, he will notice that some are almost round with smooth coats, whilst others are very much wrinkled; he will also discover, upon splitting these seed-peas open, that the substance of some of them is decidedly green in colour, whilst in others it is bright-yellow. If he carries his enquiries further and grows plants from these seeds, he will find that some produce very inflated pods, whilst others produce pods which do not exhibit this character. It was because the common pea lent itself to Mendel's purpose, by affording many such pairs of characters, that he experimented upon it. His results were, in brief, after crossing many plants differing in some one pair of characters, in every case all the offspring could be referred to one or the other of the parent forms. This character to which the offspring of the first cross could be referred, he called the dominant character, and that which disappeared he called the recessive character. From the seed obtained from a first experiment he made a second, when he found that only twenty-five per cent. of the offspring from this second cross retained the dominant character; the remaining seventy-five per cent. having reverted to the recessive character; but he also found that the offspring which remained dominant in this second experiment *continued dominant in all subsequent generations*. Carrying his experiments a stage further with the seventy-five per cent., which had reverted to the recessive character, he found *that one-*

third of these remained recessive in all subsequent generations. And still continuing his experiments with the remaining fifty per cent., he found they gave recessive and dominant characters in the same proportions as in earlier generations.

In recent years many sets of experiments have been made to test Mendel's results, and Mr. W. Bateson has initiated a movement for the thorough further investigation of the subject experimentally, whilst, on the other hand, a school of biologists led by Professor Weldon, who have been applying the mathematical methods for solving the difficult problems of heredity, contend that the results obtained by Mendel do not accord with the mathematical laws as worked out by those following the lines of enquiry laid down by Galton. These differences in the results obtained by the two schools of biologists are giving rise to much controversy, but the history of science is rich in instances in which investigations giving apparently discordant results have led up to important additions to our knowledge. We have very good ground for hoping that, in the near future, very important further steps may be made in this direction for placing our knowledge of this important subject upon a scientific basis.

A problem of great interest which has provoked much discussion in recent years, is the question whether characters which have been acquired during the life of an individual are transmitted to its offspring. Darwin under the title of "Use and Disease," admits it as possible that the power of flight possessed by wild ducks may have been lost by tame ducks in consequence of disuse. In more recent years, Weismann has convinced himself that characters of this nature are not transmitted to the offspring. The blacksmith's arms become abnormally developed in the exercise of his calling; but no instance has been recorded in which blacksmiths' children were endowed with any special development of the muscles of their arms. The feet of Chinese women have been artificially distorted for ages, but they will still develop to natural proportions if permitted to do so. The loss of power of flight by tame ducks is best explained by the survival of those varieties with small powers of flight, under artificial conditions, being favoured by selection, whilst in the wild state the birds with great power of flight can best escape from their enemies. There is, however, another description of acquired character, which cannot be finally dismissed without further investigation. Some keepers and others experienced in training dogs for sport are convinced that the offspring of dogs which have been trained can invariably be broken in with much less trouble than the offspring of dogs from equally good stock which had been kept as domestic pets. A naturalist friend of mine who has kept various species of mice in confinement, assures me that whilst the progeny of white mice, whose ancestors have been kept for many generations as pets, in their earliest stage of growth show little fear of man—though we have no evidence of this characteristic having been favoured by selection—the offspring of the field-mouse, as soon as it can run, will scamper off on the approach of man. It is difficult to explain the peculiar habits of the cuckoo, unless they were acquired at some early period. The solitary wasp, which, like the cuckoo, never knows its parents, constructs a nest or cell in which it stores small caterpillars, injured but not killed, and hangs its eggs well out of risk of damage by the caterpillars, so that when the egg hatches the grub may find a plentiful store of fresh meat at hand. Many similar examples occur amongst fishes and insects. And until we can satisfy ourselves that these animals, fishes, and insects have some means of communicating with one another in mature life, or until it has been shown how such habits can arise without having been acquired, it is difficult to dismiss altogether the inheritance of acquired characters as impossible. Professor Herring, in an address upon heredity, delivered at the Imperial Academy of Sciences, Vienna, May 30th, 1870, suggested that as it is noteworthy that every act of our daily lives is due to unconscious memory, the power of memory may be the property of all organised matter, and that it may be transmitted from one generation to another through the germ-cell. This problem should not be beyond the reach of experiment, and if established might not only explain these obscure phenomena, but many others, both in the vegetable and animal kingdom: the power possessed by roots of penetrating the soil, avoiding light and air; the habit of some flowers of poking their seed-vessels into crevices in rocks and walls or burying them in the ground; the habit of sun-dews of closing their glandular hairs when stimulated by insect prey; periodicity, so frequent in animals and plants, as, for instance, the opening of those flowers which require day-flying insects to convey their pollen from plant to plant in the morning, whilst those flowers which rely upon night-flying insects for this duty open in the evening; and many other similar phenomena. The possibility that the transmission of the power of memory from one generation to another may play some part in transmitting such habits should not be entirely dismissed until it has been tested by careful experimental investigation.

Other phenomena of heredity not having advanced since the pre-Darwinian days, we must proceed to consider the possible application of a greater knowledge of the subject to the benefit of mankind. The application of well-established rules by the breeder of animals and by horticulturists is too obvious to dwell upon. Already racing and draught horses, fat cattle, sporting dogs, brilliant flowers, luscious fruit, and other things demanded by men are attained by the practical man almost to order; nevertheless, an exact knowledge of the laws underlying these industries might bring about as great a revolution as that which has been accomplished in fields of activity by the application of principles of physical science. But a question of even greater importance remains. What effect will a more exact knowledge of these laws have upon the human race itself?

At a recent meeting of the Sociological Society, allusions were made to the "false social standard" and to the indiscriminate attachments by men and women. It was suggested that a wider diffusion of a knowledge of the laws of heredity "would bring influence to bear upon marriages." Sound knowledge of the scientific laws underlying the phenomena of nature has had a most beneficent effect upon humanity in the past, and any addition to our knowledge will undoubtedly be valuable in the future, yet the sober student must find some difficulty in foretelling the direct effect of an extension of our knowledge of heredity upon the races of men. It is difficult to conceive by what system of exact measurements we could estimate the subtle and innumerable physical and mental traits which go to the making of a Napoleon, a Bismarck, or a Darwin.

Sir Edwin Arnold foretold the destiny of the Japanese race, at a time when they were regarded by

Western people as a nation of intelligent and artistic children; but I fail to see how a scientific knowledge would enable us to derive accurate and numerical value from the subtle and remarkable qualities which have enabled Japan in a few years to raise itself to the level of a great Western nation, nor how we could set about the business of producing such a race. Without some quantitative method of measuring all the qualities which make the higher type of man, the direct application of scientific methods would be impossible.

Creation of Species.

TO THE EDITORS OF "KNOWLEDGE."

DEAR SIRS.—In Mr. Shenstone's interesting article on Heredity, on p. 17, he writes:—"The belief that every form of animal plant owes its existence to a special act of creation and . . . accorded with the tenets of the Churches."

The last few words are somewhat vague, but the only theological dogmas bearing on the subject are those held by the opposing schools of Traducianism and Creationism. The latter, it is true, held that every soul (*i.e.*, every separate life above that of the vegetable world) is separately created: this is, however, by no means inconsistent with any theory of heredity on evolution. While the more widely held theory of Traducianism—that every life is derived from another life—naturally leads to some form of evolution, and would cover the most violent deductions therefrom.

The writer's further allusions show that he is referring to popular prejudice or superstition; but it is hardly possible to style this the "tenets of the Churches."

Yours very faithfully,

Verwood, Dorset, January 14, 1905. HERBERT DRAKE.

Lighthouse Illumination.

HELIGOLAND LIGHTHOUSE carries one of the greatest searchlights actually in use, and its candle power is placed at the rather incomprehensible figure of 30,000,000. Such a figure conveys very little, but the Schuckert Company of Nuremburg, which built the light, have constructed a still larger one, for which they claim an illuminating capacity equal to 316,000,000 candles. If it were possible to set this giant on a tower three hundred feet high its rays could easily be detected 80 miles away, and those who cherish fancies about light telephony can even imagine that conversations could be made audible by it at such distances. The searchlight has a diameter of 6 ft. 6 ins., which would be a large size for a church clock, and it is built with an iris shutter, such as some modern cameras have. The leaves of the shutter slide within a fixed diaphragm in the axis of the ray of light, and the electrical control is such as to enable the shutter to govern the movement of the beam of light in horizontal or vertical directions. By the side of these the flash light lately installed at St. Catharine's Point seems but an insignificant beacon, for it is only of 15,000,000 candle power. But it is five times as powerful as the light it replaces, and it is believed that in clear weather its flicker will be perceptible from the French coast. The lens has been made in Birmingham. The revolving portion of the mechanism, instead of being mounted on rollers as hitherto, floats in a big trough of mercury, and rotation is easily and accurately brought about by a clockwork mechanism of a kind not unlike that in old eight-day clocks. The electrical energy of the light is derived from the same magneto-electric generators which have been working for 17 years now without a breakdown.

Why "Common"?

By F. G. AFLALO, F.R.G.S., F.Z.S.

THE careless use of the word "common" is apparent in our every-day language. To take a familiar instance, we call "common sense" that which is about the rarest kind of sense known. The strongest objection, however, to which the word lays itself open is in zoological nomenclature, in which it is in constant use as a trivial specific distinction: thus Common Seal, Common Gull, &c.

The two Latin equivalents, *communis*, *vulgaris*, are, if anything, yet more reprehensible, not only by reason of their greater scientific weight, but because their cosmopolitan currency tends to aggravate a geographical fallacy that will presently be indicated. I am not Latin scholar enough to differentiate the shades of meaning between the two in their zoological application to certain species of animals. In another meaning, the *sensum communem* of Phaedrus, or the *vulgaris sensus* of Cicero, the *nuances* are obvious, and can be respectively rendered, I imagine, by common sense and the feelings common to humanity. But as zoological terms I shall, subject to correction, regard them as identical, and therefore open to the same criticisms.

It is proposed, for the sake of brevity, to draw examples that illustrate the drawbacks of these terms from British vertebrate forms only; it will be easy for anyone wishing to do so to extend the inquiry to both invertebrate and exotic species.

Let us have done with the two Latin equivalents first. As regards British vertebrates, *communis* is, in the majority of systems, used of only four forms: *Coturnix*, *Grus*, *Phocœna*, and *Turtur*. As regards *Grus*, which, however common it may once have been in these islands, cannot by any stretch of the imagination be so described at the present day, it is true that Mr. Harting has adopted *cinerea* as a more satisfactory specific name for a bird rarely seen here to-day outside of menageries, though it bred freely a couple of centuries ago. Yet it is a pity that he should not also have found an equally satisfactory substitute in the case of *Coturnix*, for quails are nowadays so rare, thanks in great measure to wasteful slaughter on the Mediterranean littoral, that every occurrence is considered worth recording in sporting and ornithological journals. As to the turtle-dove, it would be interesting to know in what part of the country it can accurately be indicated as common. The marine mammal, the fourth of these, will be dealt with later.

The other Latin specific prefix is in much more general use, and nearly thirty British vertebrate forms, or approximately two-thirds, are fishes. The full list of British beasts, birds, amphibians, and fishes distinguished in many writers as *vulgaris* are as follow:—Mammals: *Sorex*, *Lutra*, *Mustela*, *Sciurus*. Birds: *Sturnus*, *Vanellus*. Amphibian: *Molge*. Fishes: *Acanthias*, *Anguilla*, *Barbus*, *Belone*, *Box*, *Conger*, *Dentex*, *Galeus*, *Hippoglossus*, *Leuciscus*, *Liparis*, *Lota*, *Merluccius*, *Molva*, *Mustelus*, *Pagrus*, *Solea*, *Thymallus*, *Tinca*.

The use of the word *vulgaris* in respect of types like the otter, squirrel, starling, or lapwing, which are the only species of their genus known in these islands, cannot be reasonably objected to like the similar use of the English equivalent "common," for the Latin designation is used in all countries subscribing to what we may term the international scientific union, and is there admissible so long as this particular species is, generally speaking, commoner than the rest. Of the lapwing, it is to be observed that Mr. Harting and most modern authorities

substitute *cristatus*, a far better distinction based on a familiar character of the bird. Although, as has been said, our criticism must not be strained in respect of the cosmopolitan *vulgaris*, it may be permissible to point out that the objection would, so far as only British seas are concerned, equally apply to all but four of the twenty-nine fishes. *Leuciscus*, *Liparis*, *Pagrus*, and *Solea* alone have more than one British species, and of these it is doubtful whether the dace is more abundant over any considerable region than the roach or minnow, while the sole—also known to naturalists, though not to those who sell and buy fish, as the "common" sole—is not only yearly growing rarer from the operations of the trawler, but is practically absent from the more northern waters of Europe, being replaced on the Scotch coast by the very inferior lemon-sole (*S. lascaris*). Professor McIntosh once attempted to acclimatise the true sole on the east coast of that country, but with what success is not accurately determined.

Leaving, however, these two Latin terms as the lesser offenders in one respect, though often the more serious in another, I revert to the use of "common," the *fons et origo* of my discontent. By a number of eminent writers it is used of the following British vertebrates :—

Mammals.	Birds.	Reptiles and Amphibians.	Fishes.
†Mole.	Wren.	Lizard.	*Sole.
Shrew.	Bunting.	*Snake (*i.e.*, Ringed Snake).	*Skate.
†Fox.	†Cuckoo.	†Viper.	
†Badger.	†Swift.	Frog.	
†Weasel.	*Buzzard.	Toad.	
*Seal.	Heron.	Newt.	
Rorqual.	†Sandgrouse.		
*Dolphin.	Sheldrake.		
Mouse.	Snipe.		
†Dormouse.	Sandpiper.		
*Hare.	Redshank.		
	*Gull.		
	Skua.		
	Tern.		

* Inaccurate. † Superfluous.

Where not absolutely inaccurate, the use of "common" is in many cases so clearly superfluous that its mere suppression with no substitute would answer the purpose. By superfluous, I mean that, as in the case of several of the fishes previously indicated as specifically termed "*vulgaris*," no other animal of the name occurs within the British region. Five of the mammals, with the sandgrouse among birds and the viper among reptiles, come under this head. In the case of the cuckoo and swift, the others of the same name are such rare stragglers that it is hardly worth distinguishing our familiar forms as "common." Only a little more than thirty occurrences (in two cases "several") of the alpine swift and three of the needle-tailed species are admitted in the last edition of Harting's "Handbook" (1901), while of the three rare cuckoos that have visited us the same reliable authority gives twelve records of one, three of another, and one only of the third. Surely, then, to write of the common cuckoo or the common swift is a waste of six letters.

The objections, apart from this one of specific isolation, to the use of "common" are two. The word, taken in its everyday significance, makes no allowance for gradual approach to extermination. This is perhaps the more serious blemish of the two. Thus, it is ridiculous to write to-day of the buzzard (*Buteo vulgaris*) as common anywhere in these islands. The zeal of keepers and the greed of pothunters have conspired to reduce the remnant of this handsome bird to almost that irreducible minimum that immediately precedes virtual extinction. Though the hare cannot be admitted to the same category, yet without doubt the operation of the Ground Game Act has in many districts at any rate all but eliminated it from the fauna. But the hare comes under the second objection by reason of its absence from the northernmost portions of Scotland and Ireland, where it is replaced by the blue form. It is, therefore, inaccurate to retain a specific designation, applicable to the whole kingdom, which ignores the predominance—if not, indeed, exclusive occurrence—of a vicarious form over considerable tracts.

This second objection applies in the case of the so-called Common Seal, Dolphin, Gull, Snake, Sole, and Skate. Correct as it may be to regard these several forms as the prevalent species in some parts of the territories or seas, or at certain seasons of the year, strong exception must be taken to such arbitrary distinction as of general application in point of both place and season. As regards, for instance, the Common Seal (*Phoca vitulina*), apart from the increasing rarity and secretiveness of our British seals, this species is by no means so common in the Scilly Islands and on the Cornish coast generally as the Grey Seal (*Halichærus gryfus*). This is pointed out by Mr. Millais in the opening volume of his splendid work on our mammals, and incidentally he gives much other information on the distribution of our various seals. Nor is the Common Gull (*Larus canus*) by any means so familiar at most of our seaside resorts, at any rate in summer, as either the Kittiwake (*Rissa tridactyla*) or Herring Gull (*Larus argentatus*), to the latter of which the term "common" might be applied with far less ground of complaint. The objection to applying the term "common" to the ringed snake is its danger rather than any error of fact, though the greater abundance of the viper (*Pelias*) over most of the island renders the use of the word in respect of the ringed snake (*Tropidonotus*) inaccurate as well as tending to inspire misplaced confidence in the more plentiful venomous serpent. With regard to the sole, something has already been said, and the Common Skate (*Raia batis*) is certainly less common on some parts of the coast than the Thornback (*R. clavata*) and elsewhere than the Homelyn (*R. maculata*).

It would be easy to extend the application of these objections, but sufficient has perhaps been said in support of a plea for revision of a term unsatisfactory on more grounds than one. Not all the objections which have been raised against any and every proposal for renaming animals, in view of priority or otherwise, can be regarded as having the same force as that which contends that the criticised term is absolutely inaccurate.

Electrical Teaching Model.

A new piece of apparatus has just been brought out by the West London Scientific Apparatus Co. for demonstrating and explaining in a simple way the various actions in the electric circuit. It consists of a series of glass tubes, through which coloured water is driven by a small centrifugal pump. By this means, current strength, electromotive force, internal and external resistance, and fall in potential down a conductor, may be clearly illustrated.

British Association Meeting, 1905.

PREPARATIONS are progressing for the meeting which is to be held in South Africa commencing on August 15.

A Central Executive Committee has been constituted at Cape Town, with Sir David Gill as Chairman and Dr. Gilchrist as Secretary; while local Committees have been formed at Johannesburg and other important centres.

Sir David Gill, Mr. Theodore Reunert, and others have taken a prominent part in the initial work. The South African Association for the Advancement of Science are cordially co-operating in the local organisation, and will join with the British Association in attending the meeting.

The aim of the Council has been to secure the attendance of a representative body of British men of science, including specialists in various lines of investigation: and that, along with the generous support of the people and authorities in South Africa, should go far to ensure the success of the meeting and to stimulate local scientific interest and research.

The Central Executive Committee in Cape Town have invited as guests 150 members, who will comprise members of the Council, past and present general officers and sectional presidents, the present sectional officers, and a certain proportion of the leading members of each section. To this list has yet to be added, on the nomination of the Organising Committee, the names of representative foreign and Colonial men of science, the total number of the official party being restricted to 200, including the local officials. It is hoped, however, that many other members of the Association will also attend the meeting.

Professor G. H. Darwin, F.R.S., is the President-elect; and among the Vice-Presidents-elect are the following: The Right Hon. Lord Milner, the Hon. Sir Walter Hely-Hutchinson, Sir Henry McCallum, the Hon. Sir Arthur Lawley, Sir H. J. Goold-Adams, Sir David Gill, and Sir Charles Metcalfe.

The Presidents-elect of the various sections are as follows:—

A. Mathematical and Physical Science—Professor A. R. Forsyth, M.A., Sc.D., F.R.S.

B. Chemistry—G. T. Beilby.

C. Geology—Professor H. A. Miers, M.A., D.Sc., F.R.S.

D. Zoology—G. A. Boulenger, F.R.S.

E. Geography—Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

F. Economic Science and Statistics—Rev. W. Cunningham, D.D., D.Sc.

G. Engineering—Colonel Sir Colin Scott-Moncrieff, G.C.S.I., K.C.M.G., R.E.

H. Anthropology—A. C. Haddon, M.A., Sc.D., F.R.S.

I. Physiology—Colonel D. Bruce, M.B., F.R.S.

K. Botany—Harold Wager, F.R.S.

L. Educational Science—Sir Richard C. Jebb, Litt.D., M.P.

The Vice-Presidents, Recorders, and Secretaries of the 11 sections have also now been appointed.

In view of the numerous towns to be visited by the Association, and in which lectures or addresses will be given, the number of lecturers appointed is much larger than usual. The list of these, as at present arranged, is as follows:—

Cape Town—Professor Poulton, on Burchell's work in South Africa; and Mr. C. V. Boys, on a subject in Physics.

Maritzburg—Professor Arnold, on Compounds of Steel.

Johannesburg—Professor Ayrton, on Distribution of Power; Professor Porter, on Mining; and Mr. G. W. Lamplugh, on the Geology of the Victoria Falls.

Pretoria (or possibly Bulawayo)—Mr. Shipley, on a subject in Zoology.

Bloemfontein—Mr. Hinks, on a subject in Astronomy.

Kimberley—Sir William Crookes, on Diamonds.

As the wish has been conveyed to the Council from South Africa that a few competent investigators should be selected to deliver addresses dealing with local problems of which they possess special knowledge, a geologist, a bacteriologist, and an archæologist have been invited to undertake this work, involving in two cases special missions in advance of the main party. Whilst Colonel Bruce, F.R.S., will deal with some bacteriological questions of practical importance to South Africa, Mr. G. W. Lamplugh (by the courtesy of the Board of Education) will be enabled to investigate certain features in the geology of the Victoria Falls, particularly as regards the origin and structure of the cañon; and Mr. D. R. MacIver, who is at present exploring in Nubia, will proceed in March to Rhodesia in order to examine and report on the ancient ruins at Zimbabwe and also Inyanga.

Most of the officials and other members of the Association will leave Southampton on July 29 by the Union-Castle mail steamer *Saxon*, and arrive at Cape Town on August 15, the opening day of the meeting; but a considerable number will start from Southampton on the previous Saturday, either by the ordinary mail-boat or by the intermediate steamer sailing on that date.

The sectional meetings will be held at Cape Town (three days) and Johannesburg (three days). Between the inaugural meeting at the former and the concluding meeting at the latter town opportunities will be offered to members to visit the Natal battlefields and other places of interest. Subsequently a party will be made up to proceed to the Victoria Falls, Zambesi; and, should a sufficient number of members register their names, a special steamer will be chartered for the voyage home, *via* Beira, by the East Coast route, as an alternative to the return through Cape Town by the West Coast route. Thus all the Colonies and Rhodesia will be visited by the Association. The tour will last 70 days *via* Cape Town, or a week longer *via* Beira (all sea), leaving Southampton on July 29, and returning thither on October 7 or October 14.

A New View of the Stars.

By T. E. HEATH.

THE usual Star Maps represent the heavens, as we see them, in perspective. The nearer stars therefore are drawn of larger and the more distant ones as of smaller magnitudes than they would be shown if it were customary to make plans and elevations of the Universe upon which everything was true to scale. We are thus confirmed in the tendency, to which we are naturally prone, to regard ourselves, our Earth, and our Sun as the most important objects in space.

Astronomers who now know, more or less correctly, the parallaxes of a considerable number of stars, being accustomed to think of stellar distances in seconds of arc, are not thus misled, but to the general reader these angular measurements do not convey much idea of distance. We are told that one second of arc (1"·00) is the angle subtended by a halfpenny, which is one inch in diameter, at a distance of 3·26 miles; that the parallax of the nearest star is only 0·75", and that stars which have only a parallax of 0·01" can just be measured. Astronomers tell us these things, but we cannot easily think in these terms.

We, in this country, are accustomed to think of small spaces in inches and long distances in miles. Now it fortunately happens that, if we represent the distance which light travels over in one year by one mile, the Sun upon the same scale will be represented by a dot (.) only $\frac{1}{107}$ of an inch in diameter, the earth by a microscopic point placed at a distance of exactly *one inch* and Neptune, at the furthest known boundary of the Solar System, will be only one pace (of 30 inches) from the Sun. If we draw a map upon this scale, the nearest known star would be $4\frac{1}{3}$ miles from the Sun, and we can put down all the stars of which the parallaxes are known upon our Map and form a clear mental picture therefrom.

We will then place the Sun at Greenwich Observatory. We shall need a table 5 feet in diameter to represent the whole of the solar system upon. We will divide space up into concentric spheres, the Sun being at their common centres. These space spheres will on our map be represented by circles. The first circle we will draw with a radius of 5 miles, to represent a space sphere of 5 light-years radius; but we shall, besides the Sun, have here only one star to locate. This will be α Centauri, and we must place it 4·34 miles from the Observatory—it will come near Bromley.

We will now draw another circle at 15 miles radius. We have 9 times the area of the first circle, but we must recollect it represents a sphere of space, and is therefore 27 times the volume of the space sphere of 5 light-years radius.

We shall here be able to map, including the first sphere, from the stars whose parallaxes are known, in

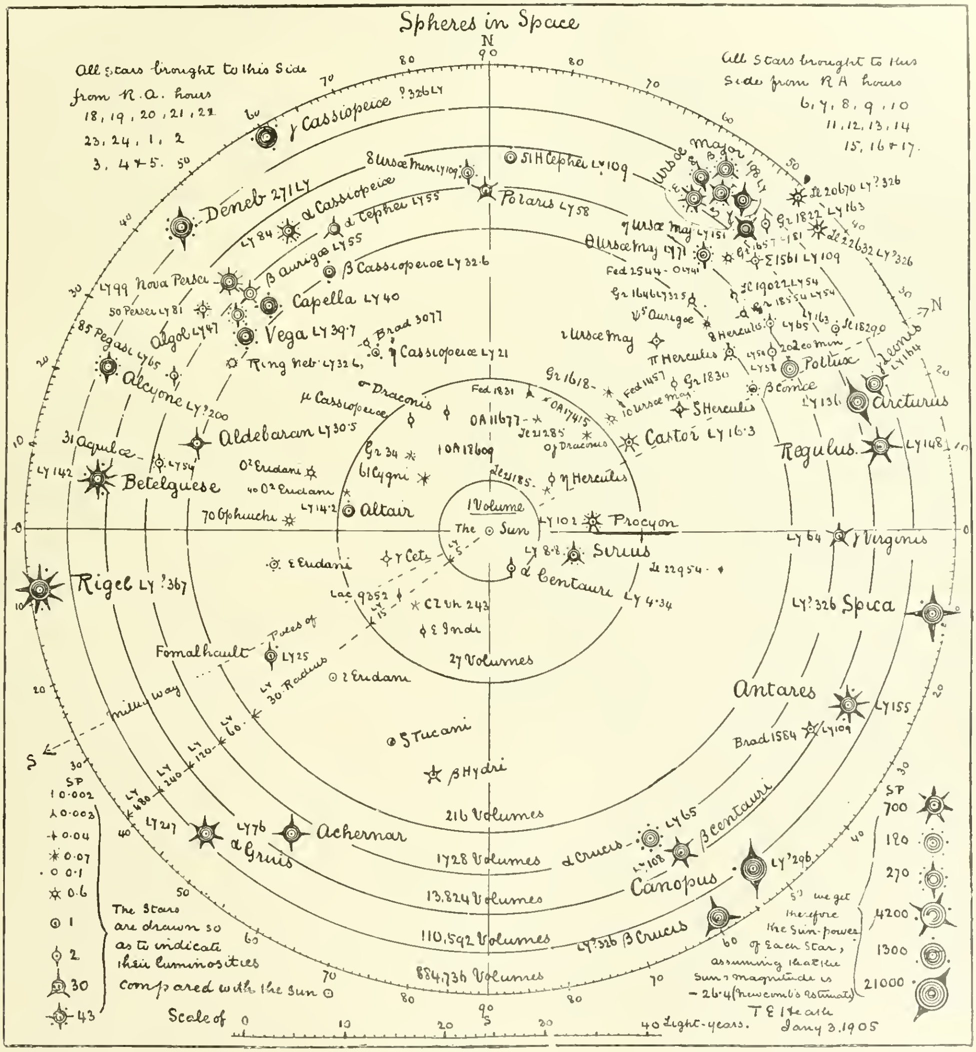


Fig. 1.

the Northern Hemisphere 14 stars, 1 central star (the Sun), and 6 stars in the South. But the Southern Hemisphere is, so far, less completely surveyed than the Northern, so that we may expect to add, say, 6 stars to the South, making a total of 27 stars.

We have, therefore, a probable average of 1 star for

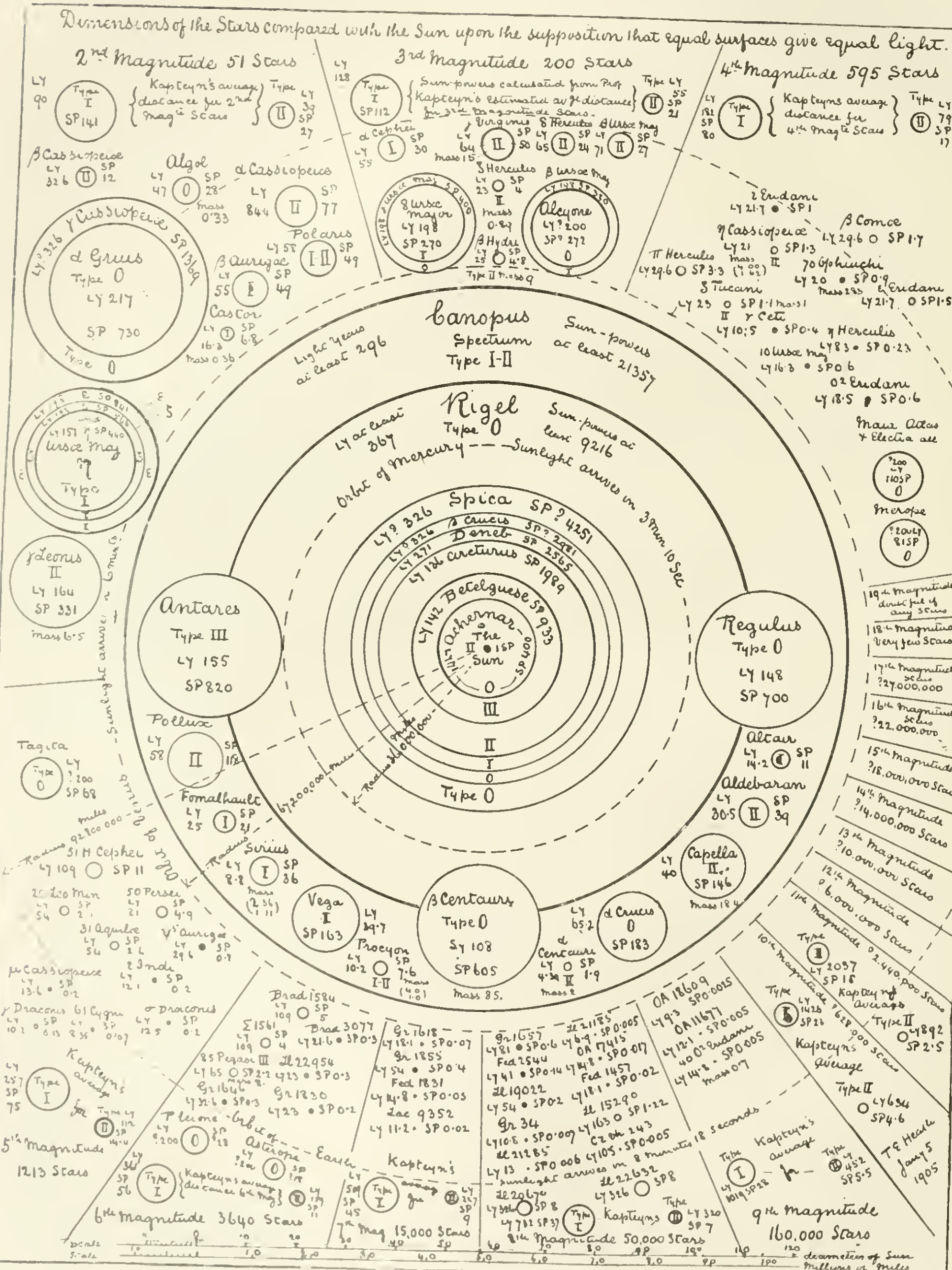

Dimensions of the Stars compared with the Sun upon the supposition that equal surfaces give equal light.
2nd Magnitude 51 Stars
Kapteyn's average distance for 2nd Magn Stars
3rd Magnitude 200 Stars
Kapteyn's estimated av. distance for 3rd Magnitude Stars
4th Magnitude 595 Stars
Kapteyns average distance for 4th Magn Stars
β Cassiopeiæ
Algol
α Cassiopeiæ
γ Cassiopeiæ
α Gruis
Type 0
LY 217
SP 730
Polaris
β Aurigæ
Castor
δ Ursæ Major
LY 198
SP 270
Alcyone
β Hydræ
Canopus
Spectrum Type I-II
Light years at least 296
Sun-powers at least 21357
Rigel
Type 0
LY at least 367
Sun-powers at least 9216
Orbit of Mercury
Sunlight arrives in 3 min 10 sec
Spica
β Crucis
Deneb
Arcturus
Betelguese
Achernar
The Sun
Antares
Type III
LY 155
SP 820
Regulus
Type 0
LY 148
SP 700
γ Leonis
LY 164
SP 331
mass 6·5
Pollux
Fomalhault
Sirius
Vega
SP 163
Procyon
β Centauri
Type 0
LY 108
SP 605
mass 85.
α Crucis
SP 183
α Centauri
Capella
SP 146
Aldebaran
Altair
Merope
Type 0
Pleione
Orbit of Earth
Kapteyn's average
5th Magnitude 1213 Stars
6th Magnitude 3640 Stars
7th Mag 15,000 Stars
8th Magnitude 50,000 Stars
9th Magnitude 160,000 Stars
10th Magnitude
11th Magnitude
12th Magnitude
13th Magnitude ?10,000,000 Stars
14th Magnitude ?14,000,000 Stars
15th Magnitude ?18,000,000 Stars
16th Magnitude ?22,000,000
17th Magnitude ?27,000,000
18th Magnitude Very few Stars
19th Magnitude
Sunlight arrives in 8 minutes 18 seconds
T E Heath Jany 5 1905
diameters of Sun
millions of miles

Fig. 2.

each space sphere of 5 light-years radius; or, in other words, the stars are probably at an average distance of 5·13 light-years apart. The survey of star distances beyond this radius is, at present, so imperfect that we can draw no conclusions therefrom as to the stellar density in space.

Professor Newcomb, however, says in his book on "The Stars" that as far as the stars which have any considerable proper motion go, they are pretty equally scattered over the sky. These are the stars which are presumably the nearest to us; in fact, no measurements we are likely to make will go beyond them, so that I will assume as far as we have measurements the stars are at intervals of 5·13 light years apart.

We will double the radius for each succeeding sphere, and, still measuring from Greenwich, we should enclose within the boundary of each space the total number of stars marked A; but, so far, I can only find parallaxes for those marked B.

Miles Radius.	A	B	Northern.	Southern.
30	216 stars	40 stars	= 28	+ 12
60	1,728 ,,	56 ,,	= 44	+ 12
120	13,824 ,,	70 ,,	= 53	+ 17
240	110,592 ,,	85 ,,	= 66	+ 19
480	884,736 ,,	93 ,,	= 70	+ 23

We have now got as far as parallaxes will take us, rather further indeed, for we can hardly place at their true distances those stars added by the last sweep. Sir David Gill, for example, says Canopus gives a parallax of 0·00″, but this only means he is sure it does not exceed 0·011″ (at least 296 light-years).

It will be instructive, however, if we continue making circles, and assume the stars still average 5·13 light-years apart.

At 960 light-years radius we enclose				7,007,888 stars.
1,920	,,	,,	,,	56,623,104 ,,
3,840	,,	,,	,,	452,984,823 ,,

But this is probably four times as many as the total number of stars which could be photographed by prolonged exposure in the largest telescopes, and Dr. Isaac Roberts has proved we thus reached the boundary of our stellar universe, because all stars shown by exposures of 7 or 12 hours are also shown, down to the smallest magnitudes, by only 90 minutes' exposure. The best estimate I could find of the total number of stars of each magnitude is by Mr. Gore ("KNOWLEDGE," 1901, p. 178). He makes the total about 100,000,000 (probably about 70 per cent. are in the Milky Way).

This map I have described, on which light travels one mile in one year, will cover England and stretch beyond. It is too big to use. I have, therefore, constructed one upon a much smaller scale, fig. 1; but to realise what it means the large map should always be kept in mind. Even so, I have only been able to set down the stars to scale as far as the 30 light-years radius; beyond that each circle on my map is supposed to be twice the radius of the preceding one. It will be borne in mind that, as spheres of space are represented by circles on a plane surface, two stars which appear near together on the map may be really far apart. The distances from the Sun, however, and from the Equator are approximately correct.

We are accustomed to think of gas and electric lights as being of so many candle-power each. I have therefore drawn the stars of different shapes, which distinguish how many Sun-powers each star is. Within the 15 light-years circle, for example, it will be found there are several stars which give less light than the Sun, and some which give more. It would take 20[illegible] stars as bright as o A 11677 to equal the Sun, but it would take 36 Suns to give as much light as Sirius, which is 8·8 light-years away.

In the map the Sun, or a star of one Sun-power, is drawn thus ⊙, and three rays are added for a star of three Sun-powers; circles are added for tens, hundreds, &c. I have however, in fig. 2, drawn the dimensions of the stars compared with the Sun on the supposition that equal surfaces give equal light. Probably this is true only of stars of the solar type.

Though small stars are no doubt equally abundant at all distances they are not equally noticeable. On our map, therefore, we shall find the Sun-power recorded increases with the average distance. For example, at 39 light-years, we get Vega 163 Sun-powers; at 40 light-years, Capella 146 Sun-powers; at 76 light years, Achernar 400 Sun-powers; at 136 light years, Arcturus 1989 Sun-powers; and at from 270 to 480 light years, Rigel, Spica, and Deneb, from 2500 to 9200 Sun-powers, and Canopus at least 21,000 Sun-powers. To make my new view of the stars I searched all recent astronomical works I could find for the best estimates of parallax. I gave the preference to those made by Gill, Elkin, and at Yale. The Sun-powers I worked out upon Professor Newcomb's estimate that the Sun's magnitude is 26·4 (Gore says 26·5), and, as far as I could, I used the Harvard estimates of stellar magnitudes.

No doubt many of the data are uncertain, but the best estimate obtainable is worth recording, though, if very doubtful, I marked it (?). It is to be hoped we shall soon have heliometer parallaxes for all the second magnitude stars equal to those for the first, and that by photography measurements will be reached for many small stars.

A model would be more instructive than a map. What could be a fitter place than the dome of St. Paul's Cathedral? The Sun in the centre and all the Stars hung round it, as their distances become known. They would be incandescent globes, and the candle power of each should be proportionate to the Sun-power of the star.

For a model, however, or for a small map, such as I have drawn, to convey any real idea of the dimensions of our stellar universe, the great world-spreading map I have described should be mentally referred to; for in that the Earth is actually one whole inch from the Sun and the solar system no less than five feet in diameter.

I do not mean that we should think of space coming to an end at a distance of 3800 light-years; indeed, we cannot think of it coming to an end at any distance. It may well be that in the infinite ocean of space there are many islands of light, of which our own stellar universe is one; we cannot tell, for we are far out of sight of any other land.

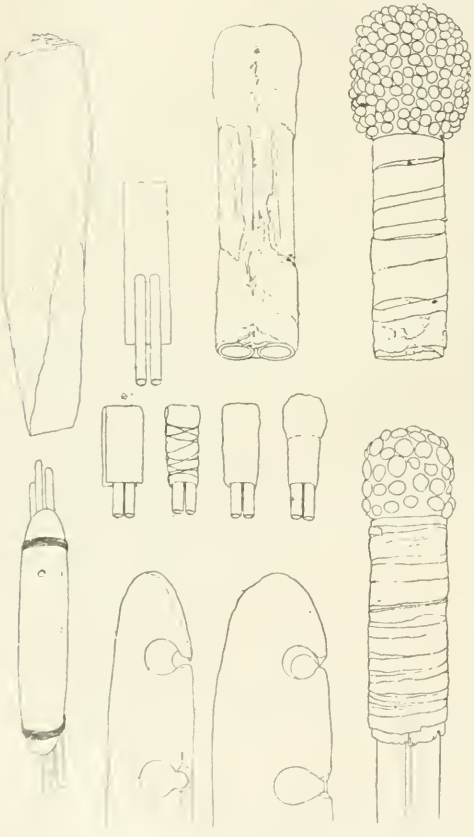
That our own stellar universe is limited is nearly certain; for otherwise, if light-giving stars be scattered throughout the whole of infinite space (unless perchance they be eclipsed by the dead, dark orbs which also wander there), the night would be as bright as the day, and day and night the whole heavens around us would blaze with an intolerable glory.

Lantern Slides.

WE have received a supplementary list from Messrs. Newton and Co. of their new lantern slides for lecture and other purposes. These include series on Radium, Sand Figures, Rock formation, Starry Heavens, Trees and Plants, and others of a scientific nature.

Queensland Fire Sticks.

SOME extremely valuable information on the Domestic Implements, Arts, and Manufactures of the Queensland natives is comprised in the Bulletin of North Queensland Ethnography, which is presented to the Queensland Government by Mr. Walter E. Roth, whose official title is the appropriate one of "Chief Protector of the Aboriginals."



Among other things described by Mr. Roth is the process of making "fire-sticks," and of using them to procure fire.

The fire-sticks are thin wands from two to four feet in length, and are often capped with a knob of beeswax and leaf or of shells. The grass tree is the one from which the fire-sticks are most often cut; and the process of firing-up has not changed from the days in which Captain Cook described it. "They take," said Captain Cook, "two pieces of dry soft wood one is a stick, the other piece is flat; the stick they shape into an obtuse point at one end, and pressing it on the other turn it nimbly by holding it between both their hands as we do a chocolate-mill, shifting their hands up, and then moving them down on it, to increase the pressure as much as possible. By this method they get fire in less than two minutes, and from the smallest spark they increase it with great speed and dexterity." To make a beginning the horizontal stick may have a small excavation punched into it with a sharp stone, &c., so as to give the extremity of the vertical one a firmer basis of support, it being very liable otherwise to slip off the rounded edge. What with the firm downward pressure and simultaneous twirling with the flats of the hands a circular concavity very quickly results: if a fresh one, some charcoal dust may be placed in it. As the concavity is being formed the finely-triturated particles removed from it collect like a miniature dust-heap around its mouth. Piled up on the underlying leaf or ground and covering over that portion of the edge of the horizontal piece contiguous with the excavation is a small pinch of fine dried-grass particles, pith-dust, bits of the prickly tops from the grass-tree, &c., arranged in such manner as actually to touch the edge of the excavation, on a windy day especially, and commonly to save labour, the pile of dried grass, &c.- the "tinder"—may be led up along an artificial nick extending from the excavation to the edge. As the finely triturated dust-particles from the horizontal piece become heated, blackened, smoked, burnt, and removed by the simultaneous twirling and friction a spark forms and comes into contact with the tinder; directly this takes place the latter is quickly whipped up, usually with a bunch of dried grass swung round and round in the air, perhaps blown on, and so made to burst into flame.

Hardly less interesting are Mr. Roth's observations on the "uses of the colours" among the aboriginals. White is essentially the colour of mourning, sorrow, and tribulation, and is met with during the ceremonies connected with burial. But in some areas of the colony and among some tribes it is a "fighting" colour, thus reversing in another sense the practice of European nations, where the "white flag" or the "white feather" have the precisely opposite significance. The usual oriflamme of war, however, among the natives is red. Red adorns warriors on their fighting expeditions, and paints their weapons; it is also found on their fire-sticks, and is even associated with magic. The Bloomfield natives by holding out the red flag can ward off impending danger from friendly spirits. On three rivers and their hinterland, however, red is associated with death, and the natives there signify mourning by a red flower or feather fixed to the forelock. Old men and women among the Brisbane blacks wear red as mourning for their children. Of less esoteric origin is the use of yellow. Yellow is the colour for withstanding heat, and in the heat of summer the natives cover themselves from head to foot with yellow pigment. It is, as a decoration, a woman's rather than a man's colour. Black is only used sparingly; and on the only occasion when Mr. Roth saw natives entirely covered with it they were representing "crows" at some very high initiation ceremonies. Mr. Roth does not agree with those who say that the natives possess undeveloped colour-sense or colour-vision. He has found words which indicate accurate subdivision of the principal colours. White, in the sense of colour, is bilbin, dingga; in the sense of light, clear, &c., especially in the case of water, kandal; as a particular pigment, garmai. Red, in the sense of a colour, is dini, and is also expressed as woba-dir, *lit.* with the "woba" (a red pigment); in the latter case, the colour is still associated with the pigment, much in the same way as we speak of the terms "raddle" and "raddled." Yellow is barga, the name of the particular pigment. Blue is dalon; the natives speak of purai-dalon, "water-blue," to distinguish deep from shallow water. There is no name for green, the existence of which colour is certainly recognised, but has not been dissociated from the objects, grass, leaves, with which it is ordinarily connected. Grey, although recognised, is appreciated only in the term for grey hair (pinga) as distinguished from the normal black hair (moari). Chestnut is yetchel, but applied to animals only. Auburn hair is called "moari-ngalan" or sun-hair, which is not unlike our expression of "sunny ringlets."

The Ears of Fishes.

By WILFRED MARK WEBB, F.L.S., Honorary Secretary of the Selborne Society.

With Illustrations from Photographs by the Writer.

THOSE who look only at the outside of a fish's head may, perhaps, be pardoned for jumping to the conclusion that it has no ears because there are no external evidences of their presence. At the same time we have only to recall the accounts which exist of carp regularly coming to be fed at the sound of a bell to appreciate that fishes hear, and, therefore, must have auditory organs of some kind. Dr. Zenneck, of Strassburg, has also shown by special experiments that fishes are sensitive to sound vibrations and are frightened when an electric bell is rung under water. Care was taken by first placing the bell in a pail to prevent any disturbance of the water which might alarm the fish. As a matter of fact, the ears of these animals are well developed, and differ only in matters of detail from our own; though in these very points of difference much of their interest lies. If we look at the first illustration, which is the photograph of the internal ear of the cod-fish (Fig. 1), we shall see that the three semi-circular canals are present which we find in the higher vertebrates, and which it is generally supposed enable us to judge of the position of our heads with regard to our bodies and to the earth's surface.

Fig. 1.—The Right Internal Ear (*auditory capsule*) **of a Cod, showing the semi-circular canals and the large otolith or sagitta in position. Seen from the outer side and slightly enlarged.**

Fig. 2.—The Large Otoliths of the Cod.

We notice, however, that the spiral prolongation of the sacculus, which we know as the cochlea, is absent from the fish, and we do not see the three small bones which play an important part in connection with vibration in the mammalia. There is a very good reason for this, for in fishes these bones are still put to their original use and form part of the ordinary skull. In bony fish, however, we find otoliths, or stony structures (Fig. 2), which may be of a large size and situated in special parts of the internal ear. Many of these ear stones are of peculiar shapes, and though the majority are white in colour, they are usually finely sculptured in a characteristic manner. There is no doubt that they make an attractive collection, and are surrounded with a good deal of interest, as we shall see.

We may first of all point out that there are typically three otoliths, and their positions are shown on the accompanying diagram (Fig. 3) taken from a drawing made by Mr. E. T. Newton, of Jermyn Street Museum, which he has been so kind as to put into my hands. The largest otolith is the "sagitta," which lies in the sacculus and is seen also in the first illustration. The second is situated not far from the first in that part of the ear which corresponds to the cochlea. The third is in one part of the utriculus, and is called the lapillus. The sagitta is usually the largest, and, therefore, is the easiest to find, especially in fish that have been cooked and brought to the table; for it is possible to pursue the study of otoliths, on occasion, at meal times. Some amusement can be had by those familiar with these objects at restaurants should small haddocks be served up under the name of whiting. The flavour may lead the diner to doubt the claims of the fish to its title, but few external characters, if any, remain which would prove it to be an impostor. Whitings and pseudo-whitings perforce are cooked with the head in place, and very little trouble will serve to make matters quite clear. The large otoliths can easily be removed with one's knife and fork from the back of the skull and the species of fish determined without a doubt. The sagitta in the haddock (Fig. 4) resembles that of the cod (Fig. 2), though it is longer and somewhat narrower in proportion, while that of the whiting (Fig. 5) is produced into a long point and is larger compared with the size of its owner. With this evidence up one's sleeve, should one be acquainted with the

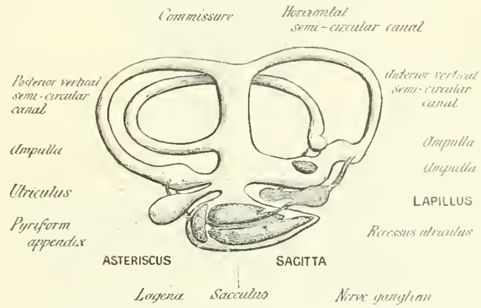


Fig. 3.—The Left Auditory Capsule of the Pike, seen from the inner side, showing the positions of the various otoliths.
(*Modified from a drawing by E. T. Newton, F.R.S.*)

manager of the restaurant, it is possible to approach him and playfully accuse him of fraud. He will, of course, stoutly maintain that the description on the menu is correct. He will nevertheless probably state his intention of consulting the contractor who supplies him with fish, and on your next visit will inform you that the fishmonger has owned that you were quite right, though only one person in a thousand, if that, is

Fig. 4.—The Large Otoliths of the Haddock.

aware of the difference between the two fish upon which you have based your contention.

As we have said before, otoliths have those characters which the collector of natural history objects is accustomed to look for, and though brittle, they are not perishable. They are not unwieldy; within limits they present great variety of shape and size, if not of colouring, and they form very pretty collections that

Fig. 5.—The Large Otoliths of the Whiting.

cannot be brought together without just sufficient trouble to keep them from becoming too common. There is fortunately another aspect from which such a collection may be looked upon. Very little is known about otoliths, and it is possible to form a very fair idea of the structures and affinities of the fish whose otoliths are found fossil by comparing them with examples from modern forms. As a matter of fact some of our modern fishes have been proved to have existed at the time that the red crag, familiar to visitors on the East Coast, was laid down. Very few collections of any size exist, and as one is necessary to the geologist who wishes to study fossil otoliths, Mr. E. T. Newton has formed an extensive one for his own use. It is surprising how much trouble may be taken and even danger experienced in obtaining

Fig. 6.—The Large Otoliths or Ear Stones of the Hake (somewhat enlarged).

a new fish of which the tiny otolith only remains to remind the enthusiastic collector. We give photographs of one or two other ear stones which are easily obtained. Those of the cod are a fair size, while those of the hake (Fig. 6) are much larger, comparatively. Those of flat fish (Figs. 7 and 8) are fairly characteristic. Turning to one or two others we may point out that the ear stones of the salmon are not particularly large, though in certain freshwater fish, such as the bream, the three stones are well developed and are more of a size than in many marine fish. The sagitta of the pike has several very elegant points. That of the gurnard has a slit at one end, while that of the wrass is practically Y-shaped. The sagitta has as

Fig. 7.—The Large Otoliths of the Plaice.

a rule a peculiar groove on one side which, as Mr. Newton has found, presents features that are characteristic of the different families of bony fishes.

Occasionally, large otoliths, like those of the cod, have been used as embroidery, while those of some Mediterranean species have been mounted to form jewellery. Probably the taste which has arisen for ornaments made from irregular pearly masses known

as "baroque" has led to this, but it must be remembered that otoliths have the porcellanous texture of the interior of the common oyster-shell and lack the sheen and play of colours characteristic of mother-o'-pearl.

Fig. 8.—The Large Ear Stones of some other Flat Fish.

Turning now to other orders of fishes we find that while ganoids such as the sturgeon have more or less well developed ear stones, the cartilaginous fishes, such as sharks and skates, have in the sacculus a number of separated grains instead of a solid mass.

Radium—the Cause of the Earth's Heat.

PROFESSOR E. RUTHERFORD, F.R.S., has written an interesting and most noteworthy article in the February number of *Harper's Magazine* under the above title. After referring to the controversy between Geologists and Physicists regarding the age of the earth, he discusses the cause of the heat in the earth and the sun, and points out that while the heat supplied by possible chemical combination is inadequate to account for this, the fact that radio-active bodies are able to emit a great amount of heat throws quite a new light on the question. "In the course of a year," says this great authority, "one pound of radium would emit as much heat as that obtained from the combustion of one hundred pounds of the best coal, but at the end of that time the radium would apparently be unchanged and would itself give out heat at the old rate." And it is probable, he adds, that it would continue to do so for about a thousand years.

The author then describes how all radio-active bodies must emit heat, although in lesser comparative amounts; thus the heating effect of uranium is probably only about one millionth part of that shown by an equal weight of radium. Yet radio-active matter has been found to be distributed, in minute quantities, throughout the atmosphere and the crust of the earth. "These emanations are not produced in the air itself, but are exhaled from the earth's crust which is impregnated with radio-active matter." Professor Rutherford then comes to a remarkable conclusion. "Since the radio-active substances present on the earth are continuously expelling α particles, heat must be evolved in amount proportional to the quantity of active matter present and to the intensity of the radiations. The question then arises, is the amount of radio-active matter present in the earth sufficient to heat it to an appreciable extent? I think that even with our present knowledge this question must be answered in the affirmative." In support of this he continues, "Since one gramme of radium emits enough heat each hour to raise one hundred grammes of water through 1° C., a simple calculation shows that the present loss of heat from the earth is equivalent to that supplied by the presence of about 270 million tons of radium. This amount may seem very large compared with the small quantities of radium hitherto separated, but is small, for example, compared with the annual output of coal from the world. It can readily be deduced that this amount of radium, if distributed uniformly throughout the earth's crust, corresponds to only five parts in one hundred million million per unit mass. This is a very small quantity, and calculations based on the observations of Elster and Geitel show that the radio-activity observed in soils corresponds to the presence of about this proportion of radium."

CORRESPONDENCE.

Spark Electrographs.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—*Re* spark electrograph shown in your last issue. During a series of investigations, made nearly two years ago,

f the phenomena preceding spark discharge, I had occasion to make many electrographs showing the field between the electrodes of the gap in the various stages of the strains breaking down the di-electric strength of the air. The enclosed are two of them. One shows the invisible brush which evolves just before the spark passes—the other is of the tentative feelers being emitted by the positive prior to the formation of the negative component.

As there is a considerable field open to experimenters in this direction you may care to publish these electrographs.

Yours faithfully,

ALFRED WILLIAMS.

Laboratory, Meadow House, Ealing, W.,
February 6, 1905.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Time Development.—This means the treatment of exposed plates to a prepared developer for a fixed time, which may have to be varied a little according to the temperature and will not be the same for different developers or plates of different makes, but which is not varied to suit the subject or the exposure. The plates are put into the developer for the specified time and then fixed and washed without inspection. The use of the Kodak developing machine renders the following of this method obligatory, for inspection during development is then impossible. There are modifications of time development that allow for variations of temperature and certain changes in the developer, but I refer now to the simple method just stated.

There has been considerable argument and some dogmatic expression of opinion as to whether time development is advantageous, whether, indeed, there is *any* advantage in any other method. The case in favour of it was very strongly set forth by Mr. R. Child Bayley, a week or two ago, in a lecture at the Society of Arts, and the Chairman, Mr. George Davison, emphatically supported the lecturer, showing prints from negatives of the same subject that had received exposures of 1, 2, 4, and 8 units of time, and had been developed together for the same time. The longer the exposure the denser the negative and the longer the exposure required for printing from it, but the prints from these negatives were all satisfactory and not very different from one another.

The advantages of such a mechanical method of development are obvious. There is no light fogging—for the plate may be kept absolutely in the dark; the fingers are not dabbling in the solution—for the plate is not removed from the dish until the time is up; all doubt as to when development is complete is removed—for any one can read a clock though few can tell by inspecting an unfixed plate whether the image is satisfactory; in the Kodak machine a whole roll of exposures is developed at once, so that much time is saved; and all risk of damage to the film is obviated because it is perfectly supported and not touched during development and fixing. The question is what do we give up for these very notable advantages? Some say, Nothing, and that what we imagine we lose is merely a matter of fancy or sentiment. With regard to the vast majority of those who develop photographs I believe this to be absolutely true, and that the net result of adopting such a method would be found to be a considerable gain in the quality of the resulting negatives. But I also doubt whether there are more than perhaps one in ten thousand of those who do a little drawing and painting whose drawings are worth as much as an ordinary photograph of the same subject, and the fact that few excel is no proof that none do or that it is impossible to excel. I am convinced that the same is true with regard to development, and that with knowledge and practice, constant practice, that is, not merely the developing of a batch of plates three or four times a year, results may be obtained that mechanical methods could not give. This leads to another question: Is it worth while even for this exceptionally able and practised worker to bestow so much trouble in personal and detailed attention when the timing method gives such an excellent yield of good results? I very much doubt whether it is unless he is engaged on exceptional work.

It will be understood that these remarks are intended to apply to ordinary photography as it is commonly understood. But I have no doubt that much scientific photography would yield a better average of results with less trouble if development were simply timed. For exactly repeating definite results, the timing method (using the same developer at the same temperature) is the only way to justify the anticipation of success.

Improvements in Colour-Photography.—Messrs. Sanger-Shepherd and Co., who have done so much to make photography in colours possible for any one who can photograph at all, are introducing some notable improvements in apparatus and methods. The repeating-back camera is still to be preferred for subjects that permit of consecutive exposures for the three negatives (the red, green, and blue records), but the advantages of a camera that gives the three negatives side by side on the same plate by one exposure are so obvious that they do not need pointing out. Such a camera they have just perfected. It has only one lens, so that the triple exposure needs no more manipulation on the part of the photographer than if he were using any ordinary camera. This means that there remain now no limitations in the character of the thing or scene photographed other than exist in ordinary non-colour photography, except that, other things being equal, the exposure for the colour photograph must be rather longer. But with the plates now in use the length of exposure is very moderate. I have seen a very good portrait of a dog which was taken in ten seconds. The camera is compact, being no larger than necessary to carry the plate in two directions, and the size in the other direction is no more than sufficient to carry the lens in the front and the plate at the back as in ordinary apparatus. A very convenient size takes the half of a half-plate, divided longitudinally, and a larger size the third of a 10 by 8 plate.

The same firm will shortly have on the market a bathed plate—that is, a plate sensitised for colour after it is made instead of being coated with an emulsion already sensitised. The great advantage of such plates has long been known, but I believe that they have not before been obtainable commercially. The advantage is that they are so much more sensitive to red and green that the exposures for these colours are not very different from that needed for the blue image. Such plates in the camera mentioned above will require an exposure of only one second instead of about fifteen for average subjects, an advantage that will at once be appreciated by all practical photographers. With such an exalted sensitiveness to red, the plate has to be developed in the dark, unless the photographer knows how, by keeping his dish covered, and so on, to avoid light fog. The plates give very clean and bright negatives.

NOTES

ASTRONOMICAL.

The Recent Large Sun-Spot.

On the 28th of January a dark streak appeared on the sun's eastern limb, which from its length, and the very extensive masses of bright faculæ surrounding it, gave promise of an unusually large disturbance. On Monday morning, the 30th of January, renewed observations showed that the spot was the largest of any seen during the present increase of activity, and in fact may have been equal to the great spot of February, 1894.

By means of suitable smoked or coloured glasses it was quite easy to see the dark area of the spot on the sun's surface with the naked eye. Observations with telescopic aid of varying powers showed the umbra or dark centre of the spot to be split up into several portions by intensely bright streaks or "bridges," and these were found to be constantly changing as the sun was seen day after day. Towards the latter part of its visibility numerous small umbræ were developed on the following side of the main spot, this being a very common feature of sun-spot evolution.

In accordance with the time of the sun's rotation, 25·38 days, the spot reached and passed round the sun's western limb on the 10th of February, its path across the disc having had about a mean southerly latitude of 16°. At its greatest development the diameter of penumbra was about 2′ of arc = about 53,000 miles The spectroscopic observations of the spot have been most interesting and instructive. As might have been anticipated from the rapid changes in the telescopic form of the spot, the spectrum lines were observed to be considerably distorted both to the red and violet sides, indicating strong vortical disturbances to be existent in the spot area. Frequently many of the special lines which are known to be distinctive of spot spectra were seen to be bright, or reversed, in comparison with the dark Fraunhofer lines. These special lines, dark or bright, were identical with those observed generally in spot spectra, and consisted chiefly of very faint lines of the rare elements vanadium, scandium, titanium, and some unknown element or elements.

Detailed accounts of magnetic measurements are not yet to hand, but it is announced that on Friday, February 3, the magnets at Greenwich Observatory were disturbed about 1.30 a.m., the effect showing throughout the day. Reaching a maximum value towards midnight, the oscillation died away on the morning of the 4th of February, about 8.0 a.m. It may be noted that the large spot was near the central meridian of the sun's visible hemisphere about the time of the magnetic disturbance.

* * *

Jupiter's Sixth Satellite.

Shortly after the telegram from Professor Perrine announcing his discovery of a sixth satellite, there came an interesting despatch from Professor Wolf, stating that one of the minor planets photographed by him was very near to Jupiter, and suggesting that this might be the suspected satellite observed by Perrine. The following data give the co-ordinates of this new asteroid, 1905 P.V.:—

R.A. = 1h. 31m. 59s. }
Decl. = + 8° 36′ 13″ } Jan. 23d. 7h. 8·8m. Koenigstuhl mean time.

Daily motion in R.A. = + 23′; daily motion in Decl. = − 9′.

The day after, however, Professor Perrine sent a further telegram, giving a new position for the satellite, and definitely stating that the object discovered at the Lick Observatory is *not* identical with the minor planet 1905 P.V. photographed by Professor Wolf. This new position of the satellite was:—

R.A. = 1h. 21m. 8s. }
Decl. = + 7° 27′ } January 17d. 8h. 44·3 (Lick mean time).

Observations on the 17th of January gave the following co-ordinates of position of the satellite with respect to Jupiter:—

Distance (r) = 36 }
Position angle (θ) = 266 } January 17·702d. (G.M.T.)

* * *

New Form of Hydrogen in Stellar Spectra.

Hydrogen is well known to be present in the spectra of most of the stars which have hitherto been spectroscopically examined, the spectrum usually shown being that consisting of a rhythmical series of lines whose wave lengths are connected by Balmer's law. In November, 1896, Professor Pickering announced that on the photographs of stellar spectra obtained with the Draper Memorial telescope there had been found a star which showed a new series of rhythmical lines in addition to the ordinary hydrogen series. Subsequent discussion of their wave lengths elicited the important fact that they were undoubtedly due also to hydrogen, but indicated conditions of temperature and pressure hitherto unknown. This star was ζ *Puppis*, which, having a southerly declination of 39° 43′, was unfortunately inaccessible to the astronomers of northern latitudes. Quite recently, however, Professor Pickering has been able to announce that by examination of later photographs of stellar spectra it has been discovered that the star λ *Cephei* has a spectrum identical with that of ζ *Puppis*, and as this star, of declination + 58° 56′, attains a considerable altitude in northern latitudes, the instruments of European observatories will be available for its examination. It is somewhat unfortunate that it is a much fainter star than ζ *Puppis*, its magnitude being about 5·6, but with the large prismatic cameras which are now installed at many observatories this will not prove a serious drawback to its being observed.

* * *

Ephemeris for Observations of Comet 1904 d.

(12·0 midnight, Berlin Mean Time.)

The following positions have been computed by Ebell at Kiel Centralstelle:—

1905.		R.A.			Declination.			Brightness.
March	1	21	4	9	+	61°	28 7	0·62
	2		9	26		61	42·4	
	3		14	43		61	55·6	
	4		20	0		62	8·2	
	5		25	17		62	20·3	0·58
	6		30	33		62	31·8	
	7		35	49		62	42·8	
	8		41	4		62	53·2	
	9		46	17		63	3·1	0·54
	10		51	29		63	12·5	
	11	21	56	40		63	21·4	
	12	22	1	50		63	29·9	
	13		6	58		63	37·9	0 50
	14		12	4		63	45·5	
	15		17	8		63	52 6	
	16		22	10		63	59·3	
	17	22	27	10	+	64	5·6	0·47

Brightness in terms of that on 1904, Dec. 17 = 1.

BOTANICAL.

By S. A. Skan.

Several plants of more than ordinary interest are figured and described in the last part of "Hooker's Icones Plantarum." *Thiseltonia*, a little plant with narrow leaves and small white flower-heads, belonging to the *Aster* family (Compositæ), and *Erichsenia*, a leguminous plant, with yellow, purple-striped flowers, are two new generic types discovered, in addition to several new species, by Mr. G. H. Thiselton-Dyer in West Australia. On plate 2785 is depicted the Chinese representative of the genus *Liriodendron*. Formerly it was regarded as a variety of the well-known Tulip Tree of eastern North America, which it very closely resembles. It seems extra

ordinary that these two species should be so widely separated geographically—one in eastern North America and the other in West China. In his "Sylva of North America," Sargent says that the genus was represented by several species in the Cretaceous age, which were widely distributed in North America and Europe. It continued to exist during the Tertiary period, with a species hardly different from *L. tulipifera*, extending over eastern North America and Europe as far south as Italy, until the advent of glacial ice destroyed it in Europe. It may be remarked that the American Tulip Tree furnishes the well-known whitewood, a light, easily worked wood often used in electric light installations. A remarkable variety of the Mahogany Tree is figured. The specimens shown were in the seedling state, and had grown only six to ten inches high when flowers were produced. Several plants, among them the common oak, sometimes behave in the same manner.

* * *

One would scarcely expect to find the original description of a new plant in the "Geographical Journal." There is one, however, in the February number, where a remarkable new Alga, named *Clementsia*, in honour of the President of the Royal Geographical Society, is described by Mr. George Murray. An unusual amount of interest is connected with this tiny plant. It was the first new organism discovered on the Antarctic expedition sent out under the command of Captain Scott. Curiously, though a marine Alga, its nearest known allies are found in fresh water, and it reminds one, on looking at the plate furnished with the description, of a *Glœocapsa*. The material was collected by Mr. Murray himself off Brazil, lat. 7° – 12° S., long. 30° – 33° W. The name selected is unfortunate, as *Clementsia* is already pre-occupied, having been given by Dr. Rose, of the U.S. National Museum, to a Crassulaceous plant, formerly described as a *Sedum*. This *Clementsia* is commemorative of Professor F. E. Clements, of the University of Nebraska, and if a valid genus the name should remain, while the Alga will have to be provided with a new one.

* * *

Monsieur Pée-Laby, in the "Revue Générale de Botanique" for December, 1904, records the curious instance of a plant of the common passion-flower (*Passiflora cærulea*) having taken upon itself a semi-parisitic existence. A seed by chance was sown near a plant of *Euonymus japonicus*. On germinating apparently normal aerial parts were produced, but below the surface of the soil a union was effected between the passion-flower and the roots of the *Euonymus*, resembling that which takes place between a stock and scion in grafting. A number of roots developed on the passion-flower, so that it was not wholly dependent on the host-plant for its supply of food from the soil.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

The Copper Treatment of Water.

During the last few months the new method of purifying drinking water by treatment with copper sulphate has been extensively adopted by large water companies in the United States, where previously some had had to discontinue the use of certain reservoirs owing to the growth of green algæ ("pond scum") rendering the water absolutely unfit for use. It has been proved that salts of copper possess extraordinary antiseptic powers, far exceeding those of either carbolic acid or formalin, and that the addition of as little as 1 part of copper sulphate to 5 million or even 50 million parts of the water is sufficient to destroy these low forms of plant life within three or four days. At the same time the growth of higher plants, such as watercress, is not injured, and the treatment is now being successfully applied to the watercress beds in the Southern States. In Professor Kraemer's opinion this difference in the behaviour of the higher plants and of algæ is due to the fact that the latter are unicellular, so that the entire functions of the organism are simultaneously affected, whereas in higher plants the copper can be distributed among the different cells and its toxic action diminished. Bacteria being also unicellular, it is not surprising that they, too, are destroyed by copper, though they offer greater resistance than the algæ. Thus Dr. Moore, of the U.S. Department of Agriculture, has found that the addition of 1 part of copper sulphate to 100,000 parts of water destroys the micro-organisms of typhoid and cholera within three or four hours. In one experiment a strip of copper placed in water containing some 4000 typhoid bacilli rendered the water sterile in four hours. As regards the influence of copper upon the human system, several leading American medical authorities have recorded their opinion that the traces of the metal in water treated by this method could not possibly be injurious. Copper is normally present in different kinds of food, and is eaten in large quantities in preserved peas, a tin of which contains many hundred times as much copper as is present in the treated water. Their general conclusion is that copper and its salts are much less poisonous than has hitherto been supposed, and that they are not cumulative in their action.

* * *

Buffalos' Milk.

The composition of buffalos' milk differs greatly from that of the cow, as has been shown by recent analyses made by Herr Windisch of the milk from three buffalo cows. It contained from 18 to 20 per cent. of solid substances, of which 7·9 to 9·2 per cent. was fat (cream) and 0·77 to 0·83 per cent. mineral salts. The milk of an average cow contains about 12½ per cent. of solid matter, of which about 4 per cent. is fat and about 0·8 per cent. mineral salts. Elephants' milk is still richer than that of the buffalo, for it contains about 30 per cent. of solid matter, including 20 per cent. of cream; while the richest of any known milk is that of the porpoise, with 60 per cent. of solid matter and 46 per cent. of cream. The milk sugar in buffalos' milk amounts to about 4½ per cent., as against about 4 per cent. in cows' milk, 20 per cent. in elephants' milk, and only 1¼ per cent. in porpoises' milk.

* * *

Yellow Arsenic.

Messrs. Stock and Siebert have shown that when arsenic is heated in a tube from which the air has been exhausted, it condenses on the sides in a brilliant yellow coating. Arsenic is best known as a grey substance with a metallic lustre, and the yellow modification is slowly re-converted into this ordinary form when exposed to sunlight, and rapidly changed when heated in the air. This is an interesting illustration of what the chemists term "allotropic modifications." Chemically the substances are identical, like blacklead and the diamond; but they differ in physical properties, such as density, hardness, and melting point.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Great Snipe in Shetland.

The "Annals of Scottish Natural History" for January records the occurrence at Unst of a Great Snipe (*Gallinago major*) which was killed on Sept. 30, 1904, and weighed 7½ ozs. The Editor remarks that if this record is authentic then it makes the second record for the Shetlands. The doubt here expressed is begotten by the weight, which he seems to regard as somewhat light for this species, since the Common Snipe sometimes turns the scale at 7¾ ozs. Mr. J. E. Harting, however, in his valuable handbook, records the weight of the Solitary or Great Snipe as varying between 7½ and 10¼ ozs.

* * *

The Beak of the Hawfinch.

It may be of interest to the readers of this column to know that in examining some skulls of the Common Hawfinch a few days since I found two skulls still retaining the beak-sheath. On examining these I was surprised to find in the region of the gape, on the inner side of the lower jaw, two large rounded bosses of the size of peas, and having a finely striated surface. On the roof of the palate immediately above, I found an

oblong, cushion-like boss, similarly striated, and stretching across the jaw from one side of the tomium, or cutting edge of the beak, to the other.

These are evidently crushing pads, and recall the similarly shaped teeth of certain elasmobranch fishes, and of *Cyamodus* among the Reptiles. So far I have not been able to find any reference to, or description of, these pads.

* * *

The Emperor Penguin.

Dr. E. A. Wilson, the Assistant-Surgeon and Naturalist of the "Discovery" expedition, gave a most interesting account of the life-history of the Emperor Penguin at the Royal Institution on Friday, January 27.

Hitherto nothing was known of the breeding habits of the Emperor Penguin (*Aptenodytes forsteri*), and consequently all will appreciate the immense amount of trouble and hardship that had to be encountered in order to track this bird to its fastnesses.

It has been stated more than once that the penguins lay but one egg, and carry this in a pouch! Dr. Wilson confirmed the opinions of those who had expressed grave doubts as to the probability of this story, and showed, by means of pictures thrown upon a screen, exactly how the duties of incubation were performed. In the case of the Emperor Penguin, the egg, and, later, the chick, is supported on the upper surface of the feet and overlapped by the feathers of the abdomen.

The coloration of the young is remarkable, inasmuch as it differs from all other penguins. The upper surface is almost white, the under surface somewhat darker, while the head is velvety black, relieved by a conspicuous white face.

The position assumed during sleep by these birds goes far to show, Dr. Wilson remarked, that the penguins once possessed the power of flight, since they still thrust the beak down between the now flipper-like wing and the body, though from the peculiarly close-fitting plumage characteristic of these birds, the comfort to be derived from such an attitude at the present day must be a minus quantity!

Why is it, the lecturer asked, that these birds choose the coldest part of the Antarctic winter for breeding?

Two "rookeries" were visited during the expedition; one at Cape Crozier, and one at King Edward's Land. The latter was by far the larger of the two, and, apparently, the more favourable as a nursery; for at Cape Crozier he estimated that the mortality among the chicks reached the amazing rate of 77 per cent.!

Save at sea, these birds appear to have no enemies, but the hunt for food is attended with many perils, the leopard seal and the killer whale displaying a great fondness for penguin meat.

Dr. Wilson is preparing a detailed account of his observations for the Royal Society, and on this account we forbear from giving further details of his discourse.

ZOOLOGICAL.

By R. LYDEKKER.

The Speed of Animals.

MUCH interest attaches to a note by Mr. Thompson Seton on the speed of certain animals which recently appeared in the *Field*. The observations were taken by the author himself with a stop-watch, and record the best speed for a mile of the various species. Although the best record for a race-horse is at the rate of nearly 35 miles an hour, Mr. Seton gives the first place to the greyhound, with a rate of 34 miles an hour. Then follow the racehorse with 32, the American prong-horn antelope with 30, the American "jack-rabbit" with 28, the common fox with 26, the coyote or prairie-wolf with 24, the foxhound with 22, and the American grey wolf with 20. A man's best speed works out at the poor figure of 14 miles an hour, while an ordinary runner who can do his mile in five minutes moves only at the rate of 12 miles in the hour. In commenting on this note, a second writer considers that the speed of the horse is under-estimated.

The Stoats of Jura and Islay.

To the *Annals of Scottish Natural History* for October Captain Barrett-Hamilton contributes some notes on the stoats of the islands of Jura and Islay. From both islands the stoats, as contrasted with those of the mainland, are characterised by their inferior size, relatively larger tail and ears, and certain peculiarities in the skull. These features are most marked in the Jura examples, those from Islay being somewhat larger. The occurrence of a stunted race of stoats in these islands with relatively large ears might, according to the author, be readily accounted for if food were scarce and good hearing an important aid in the capture of scanty prey. The increased length of tail is, however, less easy to explain. Although Captain Hamilton believes these stoats to indicate a distinct local race of the species, he has not yet proposed a special name for them.

The Musk-Ox in England.

Among the numerous species of large mammals whose bones are to be met with in a sub-fossilized condition in the gravels and other superficial deposits of this country is the musk-ox (*Ovibos moschatus*), an animal now confined to Greenland and the barren grounds of Arctic America, but which had a wide range in the northern part of the Old World during the Pleistocene Age. The musk-ox was first added to the extinct British fauna in 1875 by Messrs. J. Lubbock (now Lord Avebury) and C. Kingsley, on the evidence of a portion of a skull dug up in a gravel-pit near Maidenhead; and only six or seven other occurrences of remains of the same animal from British formations have been subsequently recorded. Recently, however, Dr. C. W. Andrews exhibited before the Zoological Society the hinder part of the skull of an old bull musk-ox, showing the characteristic bases of the horn-cores, which had been obtained from a gravel-bed at Frampton-on-Severn, Gloucestershire; and he also referred to a few bones of the same species, comprising the second vertebra of the neck and portions of the radius and femur, from the brick-earths of Plumstead. The remains of the Pleistocene musk-ox indicate a larger animal than its living representative, although, in the opinion of Dr. Andrews, the difference is not sufficiently great to render it advisable to regard the former as a race apart. If this opinion should be reversed, the name *Ovibos moschatus pallasi* is available for the Pleistocene animal.

A White American Bear.

Hitherto the polar bear (*Ursus maritimus*), which differs very markedly from its kindred in the characters of its skull and teeth, has been supposed to be the only pure white member of the group. Mr. W. T. Hornaday, in the Report of the New York Zoological Society, has, however, recently described four skins, together with portions of the skull, from British Columbia, which indicate a bear nearly related to the common American black bear (*Ursus americanus*), but creamy-white in colour. As this small white bear seems to be fairly common in one part of British Columbia, Mr. Hornaday (who cannot believe that it is a mere family of albinoes) regards it as a new species, with the name of *Ursus kermodei*.

Papers Read.

In our last month's issue the name of Mr. H. D. Imms is misprinted Jenner, the writer not having had an opportunity of revising the proofs. At the meeting of the Zoological Society on January 17, in addition to the papers recorded in the issue just referred to, Dr. C. W. Andrews, exhibited and described the fossil musk-ox skull from Gloucestershire, mentioned in an earlier paragraph; while Mr. H. E. Dresser brought to the notice of the fellows three new species of birds obtained during the Lhasa expedition. The papers read at the meeting of February 7, included one by Mr. N. Annandale, on abnormal tadpoles from India; a second by Mr. G. A. Boulenger, on East African fishes; a third by Dr. R. Broom, on some points in the anatomy of the extinct reptile *Diademodon*; and a fourth by Mr. G. L. Bates, on the mammals of the Southern Cameroons and the Benito district. Mr. Bethune-Baker also described a collection of Heterocerca from Fiji, Mr. Beddard discussed the arteries in the brains of birds, while Mr. Yearsley discoursed on the function of the antennæ of insects. At the meeting of the Linnean Society held on February 2, a paper by Dr. H. J. Hansen, was read on European *Cirolaninæ* (Isopoda.)

REVIEWS OF BOOKS.

A Popular Guide to the Heavens, by Sir Robert Stawell Ball, LL.D., F.R.S. (G. Philip and Son; price 15s. net). This book, of a handy size (7 inches by 8) and handsomely bound, consists chiefly of a number of charts, diagrams, and photographs ranging through all branches of astronomy, accompanied by some 80 pages of explanatory matter. It forms what may be called a *rechauffé* of a former work of Sir Robert Ball's which has long been out of print, but has been so greatly amended and added to as to form a new book. The author, in the preface, describes the work involved in the preparation as having been "very onerous," but records his indebtedness to Mr. Hinks for selecting the new plates, as well as for the preparation of the text which accompanies them. Among the more novel features are a series of 12 tinted illustrations of the moon in different phases, each being accompanied by its own full-page key-map. These, rather coarsely drawn, seem to us hardly worth the space bestowed upon them, especially considering that there are besides a complete chart of the moon in four parts, showing all the conspicuous features, as well as three fine photographs giving a good idea of the appearance of the lunar surface when viewed through a powerful telescope. The 12 monthly maps of the stars may also seem somewhat superfluous, being on so small a scale ($4\frac{1}{2}$ inches diameter) and, of course, containing repetitions of most of the constellations, while they are followed by 20 sectional star maps on a larger scale, as well as two key-maps. These sectional maps are on the conical projection as in Argelander's Durchmusterung Atlas, the stars being printed in black on a light blue ground, and are reprints of those which appeared in the older atlas. The book will form a very complete and reliable handbook for all students of astronomy.

Light Energy; its Physics, Physiological Action, and Therapeutics. By Margaret A. Cleaves, M.D. (London: Rebman and Co.; price, 21s. net). Dr. Margaret Cleaves divides her book rightly into two portions. In the first of them she assembles the known laws and theories of light energy from the aspect of physics; in the second she subjects the whole number of authenticated cases of light therapy to a critical examination and analysis. To the first part of her task she brings an excellent appreciation of essential points and an admirably clear method of exposition; and for the consideration of the medical and surgical aspects of "the light cure," she comes equipped with eleven years of practical experiment and investigation of actual cases. The opinions formulated by other investigators have been carefully analyzed, and the conclusions drawn therefrom submitted to searching criticism; and no case and no evidence are admitted to her pages without having shown the clearest right to be there on authenticated evidence. The result of this inclusive but fastidious method has been to present in one volume the whole of the present accredited facts concerning light therapy, with an accompaniment of illuminating exposition and suggestion. The various forms of light treatment—sun baths, arc light, incandescent light—are considered and described; and the relative efficiency of the large lamps, such as were used by Finsen, and the smaller lamps, such as have in many hospitals (the London Hospital, for example) supplemented or replaced the larger ones, is discussed. According to Miss Cleaves, the great advantage of a lamp of high power, such as the Finsen arc lamp, is that not only does the patient receive the short high frequency rays of great chemical activity, but also the waves of greater length with greater penetrability. The smaller lamps are taking in the longer waves. The applications of coloured lights and the rays at the invisible end of the spectrum are discussed, and the rays proceeding from radium and thorium, "the poor relation of radium," are considered from the therapeutic point of view. The value of the effects of radio-active emanations as demonstrated by actual cases is examined and discussed. The last two chapters deal with the methods of sensitising tissues to the action of light, in some cases by the ejection of fluorescent substances, and with the destructive effect of light in some conditions of the skin or of the organism. Dr Cleaves' compilation is an extremely valuable one, with every recommendation of thoroughness, clearness, and the properly judicial attitude.

Three volumes are before us of the "**Shilling Scientific Series**" (T. C. & E. C. Jack), 1s. each. To designate these as scientific works is perhaps somewhat a misnomer, comprising as they do but elementary and "popular" accounts of certain subjects which may have some scientific connection. "**Balloons, Airships, and Flying Machines,**" by Miss Gertrude Bacon, is the first of the series. This is a simple but accurate *résumé* of the history of Aëronautics. It contains a number of very indifferent illustrations, and a few novel expressions (one, for instance, which we would not however pronounce to be incorrect, is "Mr. Edward Spencer, grandfather of the present well-known firm of aëronauts"). The book bears no date, which is always apt to be misleading, but it is presumably only just published, and might therefore have been brought more up-to-date, for there is but the briefest reference to the Lebaudy airship, which has been so much to the fore of late. An index would certainly enhance the value of the book. But these are all the faults we can find, and anyone requiring a short but complete and reliable account of what has been accomplished in navigating the air can nowhere find a better guide than this. The next volume of the series is "**Motors and Motoring,**" a very practical little handbook by Professor H. J. Spooner, essentially, as stated, for novices. It is most satisfactory to find such an abundance of good information compressed into so small a space. The general principles of motors are fully described without digressing on the many varieties of detail now to be met with in the various makes of car. There are many clear diagrammatic figures, which render the description of the mechanism quite comprehensible to the learner. Explanatory annotations are a feature of the book, which add to the clearness, while not introducing too long a description of any one detail. The third volume is "**Radium Explained,**" by Dr. W. Hampson, and here we are led more into the realms of true science, for not only is there a wonderfully complete account of what is known of Radium, but many other side issues, such as the Structure of Matter, Ionization, Theories of Gravitation, and Stellar Systems are gone into. This is all explained in simple language, and the little work, by so good an authority, should prove most useful to those wishing information on this subject.

The Zeiss Works and the Carl-Zeiss Stiftung, by Felix Auerbach, translated from the German by S. F. Paul and Fred. J. Cheshire (Marshall, Brookes and Co.), 2s. 6d., is an interesting account of this well-known establishment. "It is by no means as well known as it ought to be that the Jena enterprise is distinguished not only by the excellence and variety of the instruments turned out by its workshops, but even more by the unique character of its organisation and the conduct of its business." This little book gives a very complete history and description of the whole affair, and appears just at the time when we read of the unfortunate loss of one of the principal actors, Professor Abbe. After briefly noticing the early history of optics, the author tells of the new era of microscope construction, the formation of images of non-luminous objects, the new glass, and the Photographic, Astronomical, and Measuring-Instrument Departments of the works. The "Stiftung" or "Trust" is then described. This was founded by Abbe, who had eventually, in 1888, succeeded Carl Zeiss as the sole proprietor of this great works. In his unselfish generosity he considered that he had no claim to be considered as a capitalist who had risked his money in founding the concern, and accordingly handed over the administration of the business to the "Stiftung" or co-operation of the officials and workmen of the works as well as the University and community of Jena. The employees are thus remunerated under two heads, a fixed wage and a result of the year's trading.

Botany. "Trees" (Cambridge, at the University Press). Volume II. of Professor Marshall Ward's admirable "Handbook of Forest-Botany for the Woodland and the Laboratory" deals with leaves. It treats of their external features, as well as of their anatomical and microscopic structure, and the metamorphoses which they undergo. Professor Marshall Ward lays great stress on the educational value to the student of the ability to draw and describe accurately the peculiarities of leaves, as a thorough comprehension of the conformation and adaptations of the leaf is "the key to the morphology of the higher plants." The language used is never unnecessarily technical, and much value is added to the work for students by the numerous and excellent illustrations.

X-Rays: Their Employment in Cancer and other Diseases. By Richard J. Cowen (London, Henry Glaisher; price, 2s. 6d.). —In Dr. Cleaves' book the Roentgen ray has not been considered, although it properly belongs to a consideration of light energy, because in the author's opinion the subject has been exhaustively treated by other writers. Mr. Cowen's book on the X-rays is not an exhaustive treatment; and makes no effort to summarize either results or conclusions. It only aims at selecting such details of X-ray treatment as may be of assistance to those practitioners who desire to make use of it; and to give hints concerning the use of apparatus and the methods and times for exposures. Incidentally, the book may be of service in disclosing to the general reader the probable limits of usefulness in this method of treatment and in dissipating some of the unfounded expectations of cures arising from it.

Practical Exercises in Chemical Physiology and Histology. Arranged by H. B. Lacey and C. A. Pannett (Cambridge: Heffer and Sons. London: Simpkin and Marshall).—In this capital little book of instruction for practical work, in which the experiments to be made are annotated for the student's benefit with the results to be looked for, Mr. Lacey and Mr. Pannett have hit the best road, if not the royal road, to learning. The description of the chemical compound to be analysed heads each exercise like the statement of a problem or a theorem; its methods of analysis follow like a problem; and the statement of the results to be expected from chemical treatment or analysis give the key to the problem. The exercises have been arranged on a course which has been found practicable in the senior classes of day science schools and in evening classes, and which will be found to meet the requirements of students preparing for physiology examinations—Stages I., II., and III., and Honours of the Science Department of the Board of Education. Some of the results obtained from the analysis of popular meat extracts have an interest for a larger section of the general public than is comprised among science students.

The Geographical Journal, Vol. XXIV., July to December, 1904 (Royal Geographical Society).—This is an exceptionally interesting volume, containing as it does the Presidential Address for 1904, the Summary of Proceedings of the National Antarctic Expedition by Captain Scott (forwarded from New Zealand), account of the Swedish Antarctic Expedition by Dr. Nordenskiold, account of the German Antarctic Expedition, and finally an account of the Antarctic Meeting at the Albert Hall and presentation of medals to Captain Scott. So that, accompanied by a number of good maps, there is a very complete record of what has been done in antarctic exploration in recent years. Besides this there are several specially notable papers, such as Major Powell-Cotton's narrative of his journey through Northern Uganda, the Rev. A. B. Fisher's account of Western Uganda, and the scientific results of Dr. Sven Hedin's Last Journey. There is also much in this volume about the Bathymetrical Survey of the Fresh Water Lochs of Scotland, and the usual interesting assortment of Geographical records, with many illustrations and maps.

Wellcome's Photographic Exposure Record for 1905 (Burroughs Wellcome & Co.), 1s. and 1s. 6d.—This neatly-got-up little pocket-book has several new features this year, amongst others being that the monthly light tables are so arranged that they may be torn out as done with each month, and a number of blank ruled pages form the Exposure record. The book is replete with information on the development, toning, intensification, exposure, &c., of photographic plates, and contains a diary, memoranda, and many useful tables, ending up with a revolving exposure calculator.

The same firm (Messrs. Burroughs and Wellcome) send us some interesting pamphlets on their exhibits at the St. Louis Exposition, which indicate in a concise manner the size and completeness of their Physiological and Chemical Research Laboratories.

We have received for review three new volumes of "The Model Engineer Series" (Percival Marshall and Co.; price 6d. net). **Model Steam Turbines,** by Mr. H. H. Harrison, lays down the principles on which these engines may be designed. It is clearly written and fully illustrated. "**Small Electrical Measuring Instruments,** published anonymously, is designed for the use of those who are engaged in the construction of small-power dynamos or electric motors, &c., and who want to make simple tests and measurements when building and using them. The explanations given are of a simple rather than an advanced nature. **The Beginner's Guide to the Lathe,** by Percival Marshall, A.I.Mech.E., is addressed, as its title suggests, to novices in the use of that fascinating instrument. It is well designed to suit its purpose, and the appliances suggested are of a simple and inexpensive kind.

How a Steam Engine Works, by W. E. M. Curnock (Dawbarn and Ward), 6d., is a practical and handy little guide for those wishing to learn the principles and practice of the steam engine, illustrated with clear diagrams. **How to Read a Workshop Drawing,** by W. Longland is another little book of the same series, which clearly explains all the different "conventionalities" of machine designs and drawings, and is well worth perusal by those who have not been instructed in such matters.

The copyright of that most useful and popular handbook, "Half Hours with the Microscope," by Dr. Edwin Lankester, formerly published by Messrs. W. H. Allen and Co., has been acquired by Messrs. C. Arthur Pearson, Limited, who have also purchased the companion volume by Thomas Davies, on the "Preparation and Mounting of Microscopic Objects." The latter has been out of print for some time, but a new and cheaper edition will be published very shortly.

Rendering Celluloid Incombustible.

In order to overcome the undesirable quality of celluloid to gnite, a French chemist has adopted the following method: An ether-alcohol solution of celluloid is made; then an ether-alcohol solution of ferric perchloride. The two solutions are mixed, and a clear, syrupy liquid is obtained, of yellow colour, yielding no precipitates. The liquid is poured into a suitable vessel and is left for spontaneous evaporation, and a substance of shell-colour is produced, which, after washing and drying, gives the desired result. The celluloid thus treated loses none of its properties of pliability and transparency, and is not only uninflammable, but is also incombustible.

Another method by which the celluloid may be rendered uninflammable, based on the same principle, consists in mixing bromide of camphor with cotton powder, adding castor oil to soften the substance so that it may be less brittle. This product, though more easily prepared, is, however, not incombustible like the former preparation.

"Solidified Raindrops."

Mr. Wilson A. Bentley, writing in the *Monthly Weather Review* (October), gives an account of studies of the comparative sizes of raindrops extending from 1899 up to the present time. The method of comparison consisted in letting the rain fall into a dish containing fine flour, and the size of the dough pellets formed afforded a measure of the size of the drops producing them. For small drops, the pellet was found by laboratory experiments to be almost exactly the size of the drops, but with large drops a certain flattening out took place. The method is very simple, and enables the features of different showers of rain to be compared at a glance, and the variations in the size of the drops at the beginning, middle, and end of a shower recorded. Presumably the wind must not be so high as to blow all the flour away. It may be suggested that people who have time to spare and wish to devote their attention to some interesting and scientific pursuit requiring little trouble, might do worse than form a collection of "solidified raindrops," and if this were done systematically by a large number of observers scattered over the country, the observations could not fail to afford a share of useful meteorological information.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Fibrous Constituents of Paper.

(*Continued from Page* 42.)

THE question of indentification is much simplified if we consider first what are the fibres we shall have to deal with. Many fibres have been suggested for use in paper-making, but in most cases either the supply has proved insufficient, or the cost of transport has been prohibitive, or the "yield" of fibre after treatment has proved to be not enough to repay the cost of such treatment and of the transport. Therefore the fibres in general use are comparatively few, which much simplifies the matter. They are principally as follows:—For white papers: linen, cotton, esparto grass, straw, and chemical or mechanical wood-pulp, and more rarely hemp and manilla hemp; for coarse papers: hemp, manilla hemp, jute, straw, and chemical or mechanical wood-pulp. It will be observed that with the exception of esparto, straw, and wood-pulp, the paper-maker gets his materials second-hand as rags, sacking, ropes, or twines, when all other use for them has gone.

To show that the matter has more than a merely academic interest, I may mention that I have several times had papers submitted to me for microscopical examination and analysis when there was a dispute between buyer and seller as to the material of which the paper was made, and where one party threatened legal proceedings against the other. The papers were sent to me simply marked A, B, C, etc., and I was asked, for instance, to say whether these papers were "all rag" or not. It is satisfactory to know that in each case I was subsequently informed that my statement had been accepted by both parties as correct, and an agreement arrived at, which may be taken as showing the value and accuracy of this method of examination.

For the identification of these respective fibres a knowledge of botany is not requisite, though it may be useful. The fibres have been so mangled and torn and twisted in the process of pulping—"beaten" is the technical term for it, just as certain Eastern nations still beat out the fibres with a mallet upon a stone—that their appearance has become much altered. But the fibres must be isolated and must be freed from all sizing and colouring matters. This is easily done by boiling in dilute caustic soda solution—one or two per cent.—for a short time, then placing on a fine sieve and washing several times with warm water, after which they may be shaken up in a bottle with some clean angular pebbles to further disintegrate them, though I have generally found rubbing with the finger on the sieve quite sufficient. Only a very small piece of paper is required, and of this only a very tiny amount of pulp is transferred to an ordinary microscope slide. This pulp must now be carefully teased out with needles so that each fibre stands free from overlying or entangling fibres, and no tufts or opaque masses are left.

The identification of the respective fibres depends on three things, none of which, in my opinion, is it safe to trust to alone: the structural appearance of each fibre, its colour reaction with certain reagents, and its behaviour with polarized light. It is fortunate that all these can be carried on without their interfering with each other.

The microscope must be provided with an analyser and polarizer, and it is of great service if the latter is fitted with a screw into which the optical part of an ordinary condenser can be placed so as to obviate to some extent the great loss of light due to polarization. The objectives suitable are an inch, or, preferably, a half-inch, and a one-sixth or one-quarter inch.

The reagents suggested have been many, of which iodine used with dilute sulphuric acid has, perhaps, been most serviceable in the past, but the reagent most used now is known as chlor-zinc iodine, and is made as follows, according to Stasburger's formula. Zinc is dissolved in pure hydro-chloric acid, and the solution evaporated to the consistence of strong sulphuric acid (metallic zinc being kept in it during the process). In this is dissolved as much potassium iodide as it will take up, and, finally, as much metallic iodine as it will dissolve. The reagent acts much more quickly in water or glycerine preparations than in alcohol.

The fibres having been teased out upon a slide as already mentioned, are freed as far as possible from water by being pressed with a piece of filter paper, a drop or two of the reagent is added, and a cover-glass placed over the preparation. Any excess of reagent may be taken up with filter paper. The reaction is almost immediate. The cover-glass is advisable not only for convenience in examination but to reduce the amount of reagent so that the resulting colours may not be masked, and also because iodine volatilises and the colours are not permanent.

(*To be continued.*)

Royal Microscopical Society.

At the annual meeting held on January 18 at 20, Hanover Square (the President, Dr. Dukinfield H. Scott, F.R.S., in the chair), the President alluded to the death of Professor Abbe, of Jena, who had been an honorary Fellow of the Society since 1878, and said that there was perhaps no one whose loss would be more felt by a Society such as their own. Professor Abbe's name was familiar to everyone acquainted with the microscope, and even those who were not able to follow the details of his work would recognise the great services he had rendered to optical science. The Secretary then read the annual report, and the Treasurer read his annual statement of accounts and balance-sheet. The result of the ballot for the new Council was announced, the President being re-elected for another year, and all the other Fellows proposed for election on the Council being also elected. The President then delivered his Annual Address, the subject being an inquiry as to "What were the Carboniferous Ferns?" At the commencement of the address the President referred to the recent death of Professor B. Renault, the well known Paleo-botanist, who had been elected an honorary Fellow of the Society as

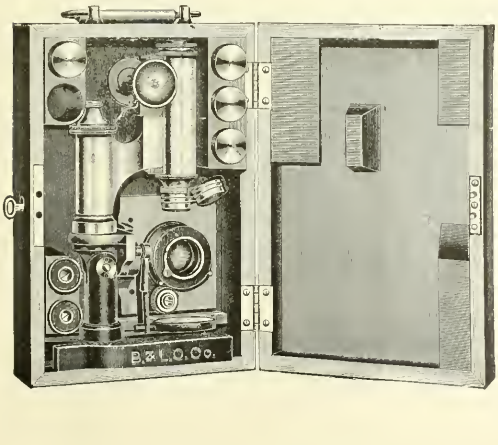
recently as June last. The address was illustrated by many lantern slides and by sections of fossils from the coal-measures shown on the screen, whilst Professor F. W. Oliver kindly lent a number of specimens, and Mr. Smedly, F.L.S., exhibited some beautiful large scale models.

The Quekett Microscopical Club.

The 419th ordinary meeting of the Club was held on January 20 at 20, Hanover Square, the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. The death of Professor Ernst Abbe, who had been an honorary member of the Club since 1879, was announced, and a motion recording the Club's appreciation of his services to microscopy and sympathising with his family in their loss was unanimously adopted. Mr. C. F. Rousselet, F.R.M.S., then gave a detailed description of his well-known compressor, describing the various features which he had considered essential to the object which he had in view when designing it, viz., the examination of the smallest living rotifers under high power objectives and with critical illumination from modern wide-angled condensers. The model was completed in 1893, and had been in use ever since with such success that he had found no openings for alteration or improvement. The various so-called "Improved Rousselet Compressors" which were on the market were, in his opinion, anything but improvements upon the original model, and he strongly disapproved of them. The Hon. Secretary then read a note by Mr. A. E. Merlin, F.R.M.S., "On the cut suctorial tubes of the Drone Fly's proboscis as a suggested test object for medium powers." Mr. Merlin pointed out the difficulties attaching to the use of the Blow Fly proboscis as a test for the $\frac{1}{4}''$ or $\frac{1}{6}''$ objective, in the hands of a tyro. Formerly the Podura scale was the most satisfactory test for such powers, but it was difficult nowadays to obtain a slide. The Drone Fly's proboscis was in structure similar to the Blow Fly's, but the detail was finer.

Bausch and Lomb's New Portable Microscope.

Messrs. A. E. Staley and Co. have sent me for inspection their new "B.B.P." portable microscope. This is a full-size microscope of the Continental type, with large vulcanite stage, sub-stage adjustable by spiral rack and pinion carrying condenser and iris diaphragm, coarse and fine adjustments, draw-tube, &c. The stage is, however, mounted on an axis, so that it, with its condenser in place, can be swung into a vertical position, a clamp fixing it when in the horizontal position, whilst the base folds together. The microscope, with objectives and eyepieces, goes into a case measuring $11\frac{3}{4} \times 8 \times 4\frac{1}{2}$ inches. This is, of course, not one of the most compact microscopes, the idea being to retain all the advantages of the full-size microscope and to add portability. The case is, therefore, too heavy for carrying any great distance. The instrument is beautifully finished, as are all microscopes made by the Bausch and Lomb Optical Company; the objectives are excellent, and the case is exceptionally handsome. The fine adjustment was, however, somewhat coarse in movement, whilst in the instrument sent me the condenser did not quite focus. The tube was of the Continental size and length, and the objectives were marked with tube-length, numerical aperture, and power, which I wish one could see on all objectives. There was also an extra diaphragm immediately beneath the stage; but this is, I always think, an unnecessary luxury.



The Postal Microscopical Society.

A perusal of the Annual Report of this Society makes one feel that its limited membership can only be due to the fact that its very existence must be unknown to the vast majority of those amateur microscopists to whom it specially appeals. The Society was founded in 1873 by the late Alfred Allen, of Bath, and its mode of working is briefly as follows: Each member contributes a dozen slides—his own make if possible; if not, good purchased ones. To these he adds a small notebook and notes on the various slides. The notes may or may not be entirely original, but they are explanatory, and there may even be one or two drawings illustrative of certain points. If the slides are his own mounting, he adds a few notes as to how he mounted them, and he may also ask for information or help on various matters from other members who will see his slides and notes. The box of slides goes in to the Secretary, who adds four slides from the Society's cabinet, making 16 in all. The members are divided up into "circuits" of seven members each, and the boxes with their notes pass on from member to member at intervals of six days, each member adding a few notes to the notebook as he passes it on. When the box has made its complete round of all the "circuits" it returns to its owner, who keeps it, the notebook, and the four additional slides, he himself having meanwhile, of course, been the due recipient of all the other boxes in due turn. This is the ideal arrangement, but it is departed from when members fail to send on their boxes according to the rules, and fail to add notes and comments other than expressions of regret for their remissness. It will be seen that the whole scheme is simple in the extreme, and it gives to every member an opportunity of seeing and studying at leisure a large number of slides on very varied subjects, of interchanging views with brother or sister enthusiasts, and of getting assistance on thorny points. Such a Society will, of course, appeal almost entirely to amateur microscopists; but to them it should be of real service, and I would suggest that any of my readers who are interested should write to the Hon. Secretary, Miss Florence Phillips, 3, Green Lawn, Rock Ferry, Cheshire, for further particulars. The subscription is five shillings per annum, with a small entrance fee.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St., Barnabas Road, Cambridge.*]

The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.49, and sets at 5.37; on the 31st he rises at 5.42, and sets at 6.28. The Sun enters the sign of Aries at 7 a.m. on the 21st, when Spring commences.

An annular eclipse of the Sun takes place on the 6th; it is invisible in this country, but visible in Australia.

The solar disc has been well marked with large sun-spots, whilst prominences have been large and active.

For physical observations of the Sun the following data may be used:—

Date.	Axis inclined from N. point.	Equator N. of Centre of disc.
Mar 2 ..	21° 59′ W.	7° 15′
.. 12 ..	24° 8′ W.	7° 12′
.. 22 ..	25° 36′ W.	6° 55′

The Zodiacal light should be looked for in the west for a few hours after sunset.

THE MOON:—

Date.	Phases.	H. M.
Mar. 6 ..	● New Moon	5 19 a.m.
.. 14 ..	☽ First Quarter	9 0 a.m.
.. 21 ..	○ Full Moon	4 56 a.m.
.. 27 ..	☾ Last Quarter	9 35 p.m.
Mar. 8 ..	Apogee	6 54 a.m.
.. 21 ..	Perigee	10 48 a.m.

OCCULTATIONS.—The only bright stars occulted during convenient hours are:—

γ Tauri (mag. 3·9) at 10.11 p.m. on the 12th.
β Virginis (mag. 3·8) at 9.2 p.m. on the 20th.

THE PLANETS.—Mercury is in superior conjunction with the Sun on the 10th, after which he is an evening star, setting about 7.30 p.m. on the 23rd; he should be looked for in the west towards the end of the month, as he is approaching a favourable elongation.

Venus is the most conspicuous object in the evening sky, being at *greatest brilliancy* on the 21st, when the planet sets about 10.20 p.m. Throughout the month the planet is well placed for observation, and is best scrutinized before darkness sets in, as outstanding chromatic aberration of the object glass is not so obtrusive. From the point of maximum brilliancy the planet appears to move rapidly towards the Sun, inferior conjunction taking place about a month later. About the middle of the month the phase of the planet is crescent, 0·33 of the disc being illuminated, the diameter being 35″. On the evening of the 9th, the Moon, Jupiter, and Venus all appear in close proximity to each other.

Mars is situated in Libra, and rises about 11.20 p.m. near the middle of the month.

Vesta the brightest of the minor planets, is in opposition to the sun on the 24th, when its magnitude is 6·3. The asteroid is describing a retrograde path near the star ρ Virginis.

Jupiter is getting more to the west and is only available for observation for a few hours after sunset, also, on account of increasing distance from the earth, his lustre is diminishing and he is altogether outrivalled in brilliancy by Venus, which appears in the same region of the sky.

At the beginning of the month the planet sets at 10 p.m., when the equatorial diameter is 35″·8, and on the 31st at 8.47 p.m., his apparent equatorial diameter then being 34″·0.

The following table gives the satellite phenomena visible in this country.

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Mr.				Mar.				Mar.			
1	I.	Tr. E.	7 15	8	I.	Tr. I.	7 2	21	II.	Oc. D.	7 10
	I.	Sh. E.	8 15		I.	Sh. I.	7 58	24	I.	Tr. E.	7 50
5	II.	Tr. I.	7 17	9	I.	Ec. R.	7 28	30	II.	Tr. E.	7 41
8	III.	Oc. R.	7 2	14	II.	Ec. R.	8 31	31	I.	Tr. I.	7 39

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is a morning star, rising about 5.30 a.m. near the middle of the month.

Uranus also does not rise till early morning throughout the month.

Neptune is on the meridian about 7.45 p.m. on the 1st, and at 5.50 p.m. on the 31st; he is in quadrature with the Sun on the 26th. The planet is near μ Geminorum, and can readily be found by reference to that star.

	Right Ascension.		Declination.
Neptune (Mar. 15).	$6^h\ 23^m\ 14^s$	..	N. 22° 21′ 8″
μ Geminorum . .	$6^h\ 17^m\ 13^s$	..	N. 22° 33′ 38″

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1–4	11 4	+ 4°	τ Leonis	Slow; bright.
,, 14	16 40	+ 54	μ Draconis	Swift
,, 24	10 44	+ 58	β Ursæ Maj.	Swift
,, 28	17 32	+ 62°	ζ Draconis	Rather swift.

Minima of Algol occur on the 18th at 0.34 a.m., and on the 20th at 9.23 a.m.

Double Stars.—γ Leonis, X.^{h} 14^m, N. 20° 22′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.^{h} 19^m, N. 11° 5′, mags. $4\frac{1}{2}$, $7\frac{1}{2}$; separation 2″·2. A pretty double of different coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3-inch telescope.

α Canum Venat. (*Cor Caroli*), XII.^{h} 52^m, N. 38° 50′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-in. telescopes.

CLUSTER.—M 44, the Præsepe in Cancer, visible to the naked eye as a nebulous patch, best seen and easily resolvable with a pair of opera or field glasses. On account of the scattered nature of the group the cluster effect is lost when observed with a telescope unless very low powers be employed. Situated about midway and a little to the west of the line joining α and δ Cancri.

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The Coming Total Eclipse.

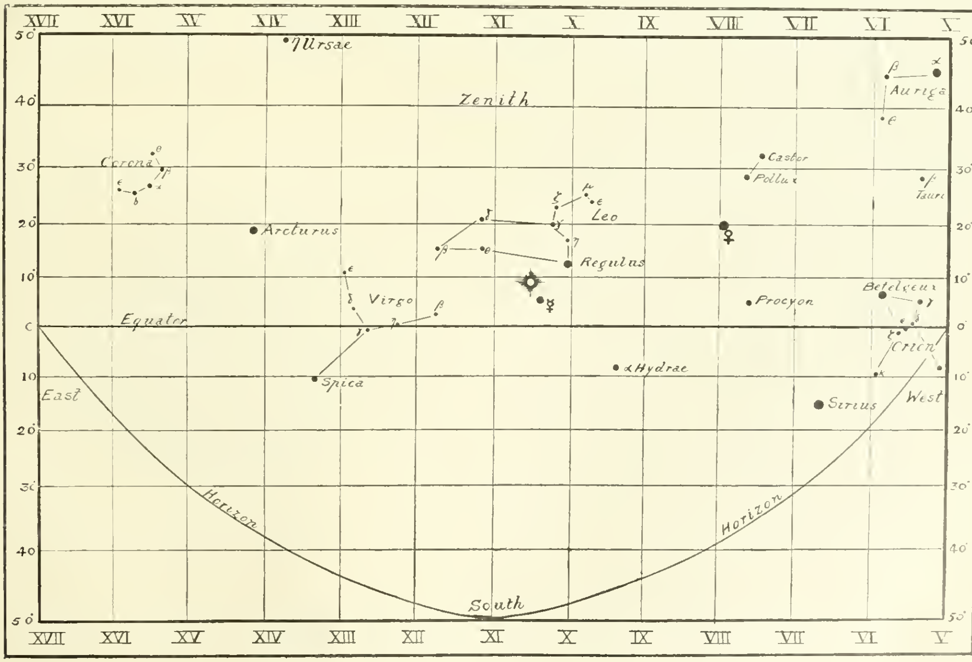
By W. Shackleton, F.R.A.S.

In addition to registering the corona on the photographic plate, bright stars included in the field of view of the lens may be recorded.

The sun will be situated in the constellation Leo, about 8° S.E. of Regulus. The chart given below shows the aspect of the sky at the time of the eclipse. It will be seen that it is the same as the evening sky near the middle of the present month about 9 p.m. Mercury will appear in close proximity to the sun, being about $3\frac{1}{4}°$ to the S.W.; the eclipse taking place only 10 hours after *inferior* conjunction of the planet with the sun, thus he will appear as a very delicate crescent. Venus is situated about 39° to the west, and is gibbous.

Observers provided with telescopes could not do better than confine their attention to the examination of coronal detail in the neighbourhood of prominences or near the poles.

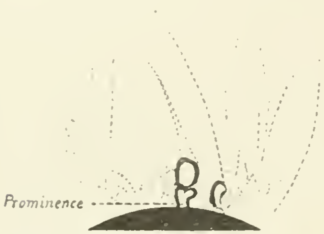
Quoting from the British Astronomical Association's Report of the eclipse of 1900: "In spite of the diffusion of photography, it may well be that in the future from time to time an observer may find himself at a total eclipse with a telescope, but without photographic appliances. There will be still work for him to do in such a case; and in any case we cannot assume, until we have both telescopic scrutiny and photographic records throughout all the varying phases of a complete solar



Aspect of the sky at the time of Eclipse (Spain). ☿ Mercury. ♀ Venus.

cycle, that the more complex and elaborate structure of the corona at the sunspot maximum may not give to telescopic examinations greater minuteness of detail than any but exceptional photographs can supply."

In recent eclipses the best photographs taken with the prismatic camera show that the images of the corona in 1474 K light are not smooth rings, but rings having a definite form not necessarily coinciding with the outline of the corona as photographed in ordinary cameras, but probably recording a true *inner* corona composed of the unknown gas *coronium.* The disentanglement of this "inner corona," or that part giving *coronium* emanations and self-luminous, from the *outer* corona, which is composed of particles or droplets, and luminous chiefly by its reflective power, is a difficult problem, since even in an eclipse it is the enveloping atmosphere and not a section of it which is presented to us. Here it seems to indicate that advantage must be taken of the outer corona giving a continuous spectrum, whilst the inner corona gives a line spectrum with its principal radiation in the green, the "corona line." If, then, a light filter be employed



Coronal detail round prominence. (Eclipse, 1896.)

which only allows this green light to pass through in effective quantities, one may succeed in photographing the inner corona alone, and thus determine the distribution of *coronium* in the corona. Gelatine films stained with aniline blue and tartrazine form a light filter of this nature; but even this may prove insufficient by itself, and possibly the spectroscope will have to be called in as an additional aid. Suppose, then, a prism from an ordinary spectroscope be fixed in front of the lens of the camera, thus making a small prismatic camera which can be accurately focussed by allowing Polaris or a bright star like Vega to trail and impress its spectrum on the plate; when this is pointed to the eclipsed sun a series of rings partially superposed will result from the radiations of the inner corona, whilst the light of the outer corona will be spread out as a continuous spectrum, and consequently enfeebled at any one point; hence, by the interception of a light filter as above described, one may possibly prevent all but the bright green ring from leaving any record. Another suggestive method, which will enable one to discriminate between these two kinds of radiations, is to take advantage of the fact that light reflected from particles is polarised, and thus, by attaching a Nicol prism in front of the lens, and making several exposures on the corona with the Nicol at various known degrees of rotation, one may be able to sift out the two kinds of radiations. A polariscope opera glass, with the Nicol between the eye and the eye lens, somewhat similar to the prismatic opera glass, would be of service as a supplementary aid. The distribution of *coronium* is a long-standing problem, and, quoting from Professor Eastman's report of the total eclipse of 1878, he says: "The limits of all the known coronal elements should be carefully determined by measurement, at each eclipse, and then the study of one important branch of solar physics will rest on definite data. The existence of the 'green line' has been established for several years, and it is a waste of valuable opportunity to stop at simply saying it was seen." The spectrum of the corona requires in general to be studied with a more powerful equipment than that so far considered. Some observers have reported no Fraunhofer lines in the spectrum of the outer corona, but it would have been more surprising if they had been seen when we learn what apparatus was employed. It is important, therefore, to devote certain apparatus to particular work; negative evidence is valuable if obtained with suitable instruments, otherwise it may be misleading. Adequate instruments does not necessarily mean "big," for, referring to the case above, an observer with a powerful spectroscope would in all probability record the absence of Fraunhofer lines, whilst another with a less powerful piece of apparatus would register their presence, and rightly so.

Yet another instance is the observing of certain phenomenon in one instrument, whilst other means fail to record it. In several eclipses observers using a slit spectroscope have recorded the presence of bright hydrogen, magnesium, and iron lines in the spectrum of the corona, and yet the prismatic camera failed to show any of these lines. In the slit spectroscope any light falling on the slit will be observable as images of the slit, and in addition to the direct light from the corona and chromosphere, there is a certain amount of light derived from the same source, but diffused by particles in our atmosphere, which is capable of illuminating the slit sufficiently to be observable. Thus, the bright lines of hydrogen have been observed to extend over the dark disc of the moon.

The prismatic camera, however, fails to register such spurious radiations of hydrogen and calcium in the corona, as no images of the scattered reflections can be formed.

The recording of the flash spectrum will form an important item in the programme, both with slit and slitless spectroscopes. It is extremely doubtful, however, whether the spectroscope suitable for this work is also efficient for capturing the spectrum of the corona; in fact, the "flash" requires both a large image and great dispersion for its disintegration and comparison with the Fraunhofer spectrum, whilst the corona would be more favourably attacked with a small image and high dispersion, in order that the lines or rings may be intense, whilst the continuous spectrum is either resolved or so enfeebled that the lines are exhibited in better contrast.

The "shadow bands" are a subsidiary phenomenon, and on this account they have usually been neglected or treated in an unscientific manner; thus we read that their progress was at the rate "of a trotting horse," and observations have usually been confined to one plane. It seems important to gain more definite information about them, whether they are due to scintillatory effects of the atmosphere, in which case wind direction may be important; or, what is more doubtful, are they some diffraction effect? Whatever be the true explanation, it seems necessary to observe them on two planes at right angles to one another, whence the plane in which they lie, or its normal, may be ascertained, and its reference to the sun or the cusps may be determined. Observation should also be made to see if they persist during totality, and especially should they be looked for at any stations of high altitude to note the effect of diminished atmosphere.

If their movement be too great for accurate eye esti-

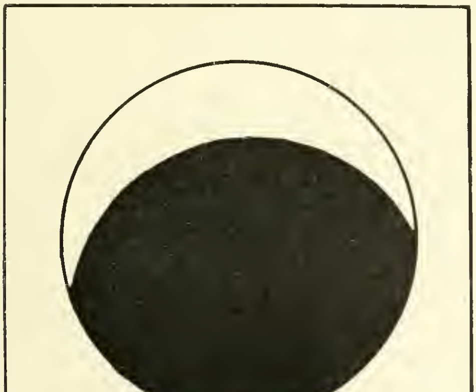
mation over a known length, observation might be made by intermittent vision, say by rotating sectors, and thus determine when they appear at rest.

Observers will be stationed at various points of vantage along the belt of totality, and arrangements have been made for the following British observers to occupy the places named :—

Spain.	
Mr. J. Evershed	Burgos.
Rev. A. L. Cortie, S.J.	Tortosa.
Prof. Callendar, Prof. Fowler, Mr. Shackleton	Oropesa.
Majorca.	
Mr. Crommelin	Palma.
Algeria.	
Sir Norman Lockyer, Dr. Lockyer, Mr. Butler	Philippeville.
Mr. Newall	Bona.
Tunis.	
Sir William Christie (The Astronomer-Royal), Mr. Dyson, Mr. Davidson	Sfax.
Egypt.	
Prof. Turner, Mr. Bellamy	

In addition to the above, American parties will observe from Canada, Spain, and Egypt, whilst three French astronomical parties have selected Burgos, Tortosa, and the Mediterranean coast, and two others intend to observe it from Sfax and Philippeville, Algeria.

It is to be hoped that the weather will be propitious, and that observers may obtain good results all along the line.



Eclipse, as visible in London.

In London the eclipse will be visible as a partial one, 8-10ths of the sun's diameter being obscured ; the diagram given above exhibits the appearance at maximum phase, which takes place at 1.5 p.m., on August 30.

With 73 per cent. of the light cut off, it should be possible to make observation of the remaining chromospheric arc to a greater depth than is usually done in full sunlight, and observers remaining at home would be doing useful work in measuring the depth visible, or in searching for the corona line at λ 5303.

It is too much to hope that the corona itself can be recorded, but it would be well worth trying to photograph the dark moon beyond the limb of the sun, for both Mercury and Venus have been visible as black discs, just before transit, signifying a background of sensible brightness compared with the aerial illumination.

Natural Gas in America.

According to the annual report of the United States Geological Survey, the natural gas industry in the United States, so far from decreasing, has shown in the last reported year a considerable increase. According to the last report of the United States Geological Survey its value in 1903 increased from £6,000,000 to £7,000,000 (not dollars) ; and there was a remarkable increase of production in Pennsylvania and Ohio. West Virginia and Indiana were the other two States in which natural gas production was of any importance, and Indiana is the only one of them recording decreased production. The general average of the price paid by the consumer increased slightly, and was about 7½d. per 1,000 cubic feet at a pressure of a quarter of a pound to the square inch. The increase in the use and consumption of natural gas in the States is no doubt to be attributed to legislative restrictions with regard to boring ; and to improved pumping machinery. The prodigal waste which characterised the early discovery of natural gas—when people used to use it almost as a plaything—has ceased, and new borings can be made only under State supervision. There seems no reason to suppose that any new areas of great extent will be found ; the gas-bearing strata are now fairly well defined, and their possibilities ascertained.

It is not a little remarkable that side by side with the increased use and value of natural gas, the output of petroleum should also be on the increase. According to Mr. F. H. Oliphant, of the United States Geological Survey, the total production of crude petroleum in the United States in 1903 was 100,461,337 barrels, a gain of 11,694,421 barrels, or 13.17 per cent. over the production of 1902. The great increase was mainly due to the remarkable output in California, which is now larger than that of any other State. California produced 24.27 per cent., or nearly one-fourth of the entire production. Next to California the largest gain in production was in Indiana, which was 1,705,515 barrels, an amount that represents a gain of 22.80 per cent. over the State's production in 1902. Kansas showed a remarkable gain in production—600,465 barrels, or 181 per cent. ; Kentucky and Louisiana showed gains of about 369,000 barrels each ; Indian Territory gained 101,811 barrels, or 274.4 per cent. ; and New York gained 43,248 barrels, or 3.86 per cent. On the other hand, there was a slight decrease of production, 128,086 barrels, or 0.708 per cent., in Texas ; and Ohio, Pennsylvania, and West Virginia all showed decreased production, amounting to a total of 1,856,619 barrels, or 3.98 per cent., in 1903 as compared with 1902. The largest decrease in production in 1903 was in Pennsylvania, and amounted to 708,724 barrels. During the last six years there has been a very remarkable change in the percentage of the local production. The Appalachian and the Lima-Indiana fields, which for many years produced all but a very small percentage of the whole, produced in the year 1903 only 55.38 per cent. of the total, whereas in 1898 these fields produced 93.99 per cent. of the total. California and Texas have been the most important factors in bringing about the readjustment of the percentages of production.

"Ad Infinitum."

The Structure of the Atom.

By BERESFORD INGRAM, B.A. (CANTAB.), F.C.S.

PROF. J. J. THOMSON'S lecture at the Royal Institution on March 10 on "The Structure of an Atom" must have been bewildering to an extreme to all those who are not acquainted with the most recent developments of science.

To many of us an "atom" conveys but a very vague idea. We think of it as something smaller than one of those fine dust particles we see floating about in air when a beam of sun-light enters a room. We are told it has weight, but at the same time we are instructed that we have no means of weighing it. A reasonable conception of its size can be gained by imagining an ordinary drop of water to be magnified to the size of the earth, then the particles composing the drop would be the size of cricket balls.

Chemistry has taught us how these particles arrange and behave themselves one to another, but physics goes further than that, and proposes to show us of what and how these particles are made up.

Over ten years ago Prof. Thomson proved that one of these *atoms** of hydrogen is composed of one thousand smaller particles. All these particles or "corpuscles" have the same mass, and are similarly charged with negative electricity.

If this be so, then they must all repel one another. This fact compelled the physicist to consider all these particles being held together by a positive charge of electricity, an assumption which, to some extent, was warrantable by reason of the fact that positive electricity is always found associated with large masses of matter.

Thus the simplest form of matter that can be imagined is one of these negatively-charged corpuscles being surrounded by a sphere of positive electrification.

Before anything further can be known about the atom we must find out how these corpuscles arrange themselves when there is more than one in the atom.

This is, to some extent, experimentally demonstrated by taking some short thin rods of steel and magnetising them. They are then stuck through corks, and so arranged that when placed in water they will float perpendicularly with their north poles uppermost out of the water. In this way the magnets can move in one plane only, *i.e.*, that of the surface of the water; but it must be borne in mind that the corpuscles composing an atom are assumed to be free to move in any direction.

When two such magnets are placed in water they, of course, assume some position apart from one another; three form an equilateral triangle; four form a square, five form a circle with the magnets at equal distances from one another, six form a circle with one in the middle.

The following list shows how the magnets would arrange themselves when thrown indescriminately into the water, from which we conclude that such is their position or arrangement of equilibrium.

No of magnets	5,	7,	[illegible]	9,	11,	13,	19,	23,	30,	36..	272
Outer ring ..	5,	6,	7,	8,	9,	10,	12	13,	15,	16..	40
Inner ring ..	0,	1,	1,	1,	2,	3,	7,	10,	15,	20..	232

* An atom is defined as the smallest quantity of an element which can enter into combination with any other element.

The arrangement is found to be more stable, the greater the number of magnets within the inner ring.

Supposing an atom to contain twenty such particles, then from the above table we could find out how they arranged themselves. Look along the first line of numbers and select the one nearest to twenty; it is nineteen. This, as is observed, arranges itself twelve in the outer ring and seven in the inner; there is still one corpuscle over which would go *within* the inner ring and increase the stability of the atom. Similarly, an atom with 21 corpuscles would have twelve in the outer, seven in the inner, and two in the inmost, and would be even more stable than the atom with twenty corpuscles. Twenty-two corpuscles would make a more stable atom still. When, however, we get to twenty-three corpuscles a new arrangement takes place in which we get two rings only—thirteen in the outer and ten in the inner. As the number increases from twenty-three to thirty, we get a whole series of bodies with increasing stability (since the extra corpuscles are entering the area of the inner ring) until we come to thirty, when we suddenly get another arrangement.

But this is exactly what we get in the periodic classification of elements. Starting with lithium, and taking the elements in order, as their atomic weights increase, we find we go from elements of marked electro-positive nature to those of decided electro-negative, then suddenly it reverts to an electro-positive element and the gradation to the negative element starts all over again.

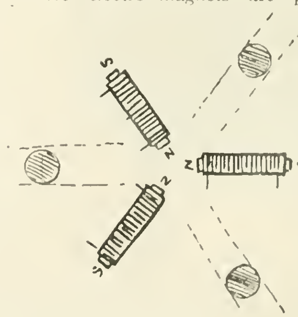
Thus sodium, which marks the sudden reversion from electro-negative to electro-positive elements, may be considered as containing the arrangement necessary to give lithium its electro-positive properties with another ring (arrangement) or rings, that have no odd corpuscles, added on to it. If, by any means, hereafter to be discovered, the atom of sodium could be robbed of its extra ring or rings, *as a whole*, we should expect the transmutation of sodium to lithium to have been effected.

So much, then, for the arrangement of the corpuscles forming the atom; now let us turn our attention to the behaviour of the atom itself.

Even a superficial knowledge of chemistry would be enough to force upon us the conviction that there exists some constant law controlling the movements of the atoms composing an element.

A study of the following experiment will show very clearly that the atom does not obey any of the existing laws which are known to control matter.

Three electro-magnets are placed as in figure, with their north poles pointing towards a centre. Between the angles so formed are placed three vessels of water which allow one magnet to float perpendicularly in each, north pole uppermost. The magnets are so arranged by guiding wire that they can only move along a line which bisects the angles between the magnets. Imagine, for the sake of illustration, that the electro-magnets in the centre form a



nitrogen atom, and that the magnets in the water are hydrogen atoms.

Now switch on the current and observe the floating magnets; they all approach the "nitrogen atom" up to a certain distance and no further. The movement is very decided at first, but slows down gradually up to the said point. Move the "nitrogen atom" round so that the movable magnets ("hydrogen atoms") are in a direct line with the electro-magnets and the movements of the former obey the ordinary laws of magnetic repulsion.

The experiment seems to point out that the condition essential to stability in chemical combination is that "*the attraction of one atom to another* (or others) *increases as the distance increases.*" It is thus the opposite to the law of inverse squares.

It would also seem to show that combination is only effected when the atoms have taken up a definite position one with another.

We may suppose an atom to have around it certain regions which are habitable by other atoms, and when the former are occupied by the latter a stable body results.

This would harmonise with our ideas of valency and make the suggestion reasonable, that an element may be polyvalent, since it is supposed to have so many "valency regions" which may or may not be occupied by other atoms.

A carbon atom is said to have four such valency regions. If, now, two carbon atoms are brought together in such a way that one valency region of one carbon atom comes into intimate contact or coincides with one valency region of the other carbon atom, then the region referred to is rendered uninhabitable; the two carbon atoms are held together by a force which obeys the law enunciated above, and we get a ready and adequate conception of the constitution of ethane $C_2 H_6$. Similarly when two "valency regions" of the carbon atoms coincide we get the constitution of ethylene $C_2 H_4$, and when three (since the regions must not be supposed to be in one plane), we get the constitution of acetylene $C_2 H_2$.

So little is known about the properties of electricity that it may be doubted whether the atoms are, indeed, electrified; but apart from the mathematical calculations based on that assumption, which confirm all the known facts, there are other sources from which evidence can be drawn, one of which is especially worthy of attention:—

> "Solutions of certain compounds are observed to rotate the plane of polarization."

If atoms are charged, the explanation of this phenomenon is simple and straightforward. If, however, the assumption is rejected, the explanation becomes complex and unsatisfactory.

For many years the scientific world has been satisfied with its conception of the atom as first taught by Democritus and afterwards strengthened by Dalton as a result of his quantitative experiments.

This conception successfully grappled any difficulty that could not be explained except by assuming that the atom was a small indivisible particle.

It is only comparatively recent research in physics that has demanded its sub-division, and although this does not effect its definition as far as the chemist is concerned, yet others may ask "Can this corpuscle be divided?" Shall we hear some physicist in later years expatiating on the structure of this corpuscle, or shall we be told that now we are as far as we can go, since the corpuscle is the smallest mass conceivable?

How Britain became an Island.

By Edward A. Martin, F.G.S.
Author of "A Bibliography of Gilbert White," &c.

There are few phenomena which appeal to the imagination so vividly, and bring to mind the solid geological fact that what is now land was not always dry land, and that where now rolls the open sea was not always covered by the waters of the ocean, than what is known to sea-faring men as the Dogger Bank.

As a geologist, one is frequently being asked whether it is a fact that this or that place in which the questioner happens to be interested for the time being was at one time beneath the sea. Those who have not grasped the great geological truth that the level of the land-surface has constantly changed in the past, and even now, in many parts of the world, is undergoing either subsidence or elevation, frequently express considerable surprise when they learn that the earth's crust is continually subject to vertical movements; and greater surprise still is shown when it flashes upon them as a geological fact, that Great Britain was not always an island; and that since the time that our country was inhabited by mankind, it had a continental existence, being, in fact, but a portion of a north-western extension of the continent of Europe.

Although, at a later period in its history, England formed a peninsula which was connected with Europe only by a narrow neck where now are the Straits of Dover, yet, at still earlier time, we have ample evidence to show that Ireland was joined to Great Britain, and the latter to Denmark and Scandinavia. This could, of course, only be so when all those now isolated countries formed portions of a vast plateau, when the seaboard was at some considerable distance from the present coast, and the whole was at a much greater elevation above the sea than now.

It is a well-known fact to mariners that when they pass out of the English Channel into the Atlantic, in a comparatively short distance they pass from shallow depths to those which are ten times as great. The same experience is gained in going west from any point on our west coasts, and also in a northerly direction from the north of Scotland. But it is very different on our eastern coasts. With exception of a narrow strip off the Norway coast, which would appear to have been at one time the bed of a rapidly-flowing river with considerable power of excavation, the whole of the North Sea is shallow, as compared with the depths found in other seas of the same magnitude.

If we look at one of the hydrographical maps of the Admiralty, we shall see that the hundred-fathom line is found some little distance beyond the north of Scotland, and that thence it proceeds in an easterly direction almost to the coast of Norway, leaving the North Sea to the south of it, and all of that sea enclosed within that line is under 100 fathoms, or six hundred feet deep. This is a very shallow depth for a sea of the size of the North Sea.

Now follow the same 100-fathom line around our west coasts, and we find that it proceeds some considerable distance beyond the outermost of the Hebrides,

when it turns south, so as to include within it the whole of Ireland. Then, following the same line still further south, it is found off the entrance to the English Channel, when, crossing the Bay of Biscay, it reaches very near to the coast of Spain. It is when we pass beyond the limits of this line that we find a comparatively rapid descent into oceanic depths. In fact, it roughly represents the coast-line of the plateau-like extension on which the British Isles stand, and is in itself evidence of a great probability that up to that limit what is now the bed of the ocean was once dry land.

The changes which have since taken place form a history of extreme interest, but it must be borne in mind that great though the changes were, they were extremely gradual in their accomplishment. After the great plunge which had visited these islands in the middle of what is known as the Ice Age, the area of the North Sea had become a mass of ice, and this, travelling westwards from the heights of Scandinavia, had turned aside the numerous smaller masses of moving ice which had been given birth to by the Scottish mountains, and the heights of the Pennines and Wales. The result was that such parts of our higher lands which were above the sea-level were submerged beneath the ice-sheet, and the whole country must have presented an appearance not unlike Greenland of the present day. Possibly here and there the highest points of our mountains projected through snow and ice, forming prominences, or "nunataks," similar to those seen by Nansen when crossing Greenland. But at the height of the glacial period, probably even these were covered, and right away from an elevated Scandinavia the ice slowly moved westwards, and, overflowing our islands, passed on to break up into icebergs in the ocean to the west and south-west.

The submergence of the islands lasted, humanly speaking, for a long period of years. From a geological point of view it lasted long enough to allow of the formation upon the glacier-formed boulder-clay of certain shell-bearing gravels; but as these are now at heights of 1,800 or 2,000 feet above the sea-level, there has apparently been, since these inter-glacial days, an uprise of the land to that extent. Such shell-beds are found near Macclesfield, at Moel Tryfaen, and on the shores of the Clyde.

We are here therefore presented with the fact that an enormous elevation of the land took place, and that this happened after both sea, and what little land there was left, had been submerged beneath the great ice-sheet.

Apparently by this time a decline had set in so far as the severity of the climate was concerned. The glaciers in our own mountain regions commenced to reassert themselves, this being only possible when the Scandinavian intruder commenced to retire. There was no longer a sea of ice. Switzerland or the Himalayas would give us a truer picture of our country at this time, when the glacial conditions were on the wane.

Many of the boulders which are now scattered about far from their place of birth may have taken their journeys at this time; or those that had journeyed during the period of the first formed boulder-clay may now again have been taken up by the recurring glaciers, and sentenced to retransportation. The great lumps of shap granite that one sees at Robin Hood's Bay and at Heyburn Wyke, or in the churchyard at Grosmont, may have been brought to rest now, far from the home of their birth in the Westmoreland Hills.

The re-elevation of the land must have had marked effect upon the coast-line. Probably the movement went on until the coast was thrown outward to the 100-fathom line, and our country was but a central portion of the great plateau then exposed. There was no English Channel left, and hence the Channel Islands and our own Isle of Wight were continentally connected. The Bristol Channel was non-existent. There was no St. George's Channel between Ireland and Great Britain. The Hebrides, the Shetlands, and Orkneys were all part of the land-mass, and the North Sea was non-existent.

In the centre of the North Sea there was at this time an area of about 300 square miles, which was considerably higher than the surrounding North Sea Plain. This was situated some 100 miles off our present Northumbrian and Yorkshire coasts, and what is now left of it beneath the sea is the famous Dogger Bank.

On the whole, this plain must have been a wide, dull, and uninteresting flat extent of land, but although it had but few heights, it was eminently suitable to be the habitat of herds of wild animals. For, in the course of time, the ice passed away completely, forests grew upon the land, with pasturage suitable for the vegetarian livers who swarmed upon it. This was at the time when the British elephant was in his prime. Herds of bisons roamed over it. Crowds of reindeer and Irish elks added picturesqueness to the landscape. And in the waters and rivers the woolly rhinoceros and the hippopotamus disported themselves.

But what of the rivers which watered the land? Where did the rivers of Germany turn to in order to find an exit into the sea? Where went our Thames, our Severn, and our southward-flowing rivers?

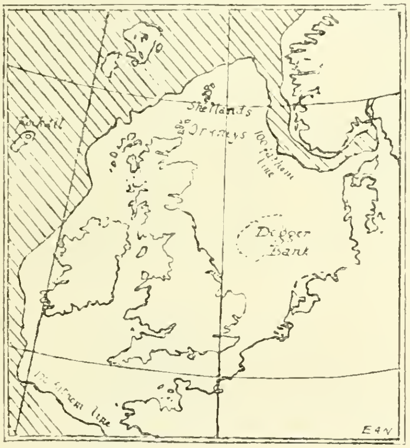
There being no English Channel, a river which rose in the submerged Wealden area between Hastings and the French coast no doubt passed westward to the ocean, receiving on its way as tributaries the rivers on the French and English coasts. The Severn and a river from the Irish Sea may have joined to form another such river, and this may have also joined the Channel stream. Our Neolithic progenitors, in coming to us from the Continent, would have had to cross this river, but with the many monuments which they have left of their civilisation this would not probably have caused them any difficulty. For the greater part their journey would have been on dry land.

The German rivers no doubt excavated their own valleys across the plain and emptied themselves into the northern ocean.

But what became of the great Rhine? As it now emerges into the sea, it seems to point to the west. But it could scarcely have continued in that direction, for the parallel ranges of chalk downs were then existent between the English and French coasts, and these would be sufficient to turn the river northwards. There is little doubt, in fact, that it travelled north, some little distance off our British coasts, and that the Thames and all our eastward-flowing rivers formed tributaries on its left bank. Some of the most important fishing grounds now seem to be in the valleys scooped out by this long-ago greatly-extended Rhine.

This condition of affairs did not last long in geological time. The sea had for some time been creeping up the English Channel and forming raised beaches at Freshwater, Brighton, and elsewhere, and, when Scotland and Northern England began to sink, together with the North Sea Plain, the sea began to encroach

upon its former dominions. The animals retreated farther and farther south, until many of them took refuge upon the high land of the Dogger Bank. This, in the course of time, became an island, the sea soon enclosing it on every side. In the trawling operations which are constantly going on in the region of the Dogger, many bones and teeth of the mammoth and other animals now extinct in those regions are constantly being brought up. In fact, scarcely a trawl is brought to the surface that does not contain some of these remains. Now why should they be found there in such abundance? Probably the various currents which were brought into play as the surrounding parts came to the surface may have been responsible for banking up hereon many of the bones, &c., collected from the area which was sinking into the sea. But there seems also good reason to believe that the Dogger



Island formed a veritable place of refuge, where were congregated during the last years of its existence the numerous animals who had been driven south, who had here been stranded involuntarily while the advancing sea cut off their retreat. Between the time of its having become an island and its own final disappearance beneath the ocean, not many thousands of years may have elapsed. There would be no time for the evolution of fresh species. Those that were first here isolated were of the same kind as those who were finally starved out, or overwhelmed in the advancing waters. There in the end they succumbed, and their remains are now brought up in the North Sea trawling nets.

We can pursue the evolution of the British Isles a step further. Britain had by this time received its complement of Neolithic savages, whilst Palæolithic man, who had seen the advent and disappearance of the great ice age, had also disappeared before the march of the more civilised Neolithic man. Owing to the absence of true glacial formations in England south of the Thames, it is considered that these parts at no time were the nursery grounds of glaciers, and that they did not participate in that great subsidence which visited all those parts which were subjected to the enormous weight of the great ice-sheet. The North Downs were all the while continuous from the Forelands and from Folkestone to the Continent, as well as the South Downs from Beachy Head, and the intermediate Wealden Heights from the neighbourhood of Hastings.

When the sinking took place in the bed of the English Channel, which allowed of the approach of the sea, the action of the waves, aided to an important extent by tide action, soon widened the Channel by eating away the soft tertiary strata which probably covered the chalk. Then attacking the chalk it formed cliffs of this rock, and the work proceeded until the sea had encroached to a point east of Brighton on the British coast, and a corresponding position on the French coast. Here was a pause, to which are to be attributed the raised beaches, which rest upon ledges in the chalk, with the old chalk cliffs behind them.

But soon the pause came to an end. The sea again advanced, and cut through the beaches it had formed at the eastern end of the English gulf. Thus was lost the connecting sea-margin between England and France. Probably this eastern shore was pierced at more than one place by short rivers, which were then draining the Wealden saddle-back ridge which formed the backbone of the Anglo-French isthmus. Others may have flowed in the opposite direction and have been at one time part of the great Rhine system. Similar rivers piercing our present chalk downs and taking their rise in the Weald are seen in the Sussex Ouse, the Arun, and Adur; in the Mole, the Wey, and the Darent; but in these days they were powerful rivers, and flowed from a greater height than now.

The advancing sea would creep up the beds of these imaginary rivers, widening their valleys as it advanced. Soon it would reach the low parts of the Weald clay between the two parallel ridges of chalk downs, and the English Gulf and the North Sea would join hands by the connection provided by the river valleys. Thus the chalk hills would be attacked in the rear, and in the course of a short geological period the chalk isthmus would be gradually planed down, and the incipient Strait of Dover become an accomplished fact. Once the passage had been made for the tides, the breach would quickly widen, and the isolation of Britain thus became assured.

The position gained has been maintained. Britain an island had been the end to which geological agencies had been moving for many thousands of years. Now the end was gained. Britain an island had become an accomplished fact, and in spite of numerous subsequent minor movements she has retained that position which Nature gave her—an island set in the silver sea.

Absorption of Mercury Vapour by Aluminium.

M. Tarugi has recently been investigating the power which aluminium has for absorbing mercury vapour. This is manifest even when the vapour is largely diluted with air, and at the temperature of the surrounding atmosphere. This property constitutes a very delicate method of analysing the presence of mercury, and furnishes a means of prevention against poisoning by its vapours. A respirator has been constructed in which the air, before entering the lungs, has to pass through a mass of finely-pulverised aluminium, and in this way all traces of mercury are absorbed so completely that breathing can be carried on even in the dense vapours produced by the burning of chloride of mercury.

Monoclea Forsteri.

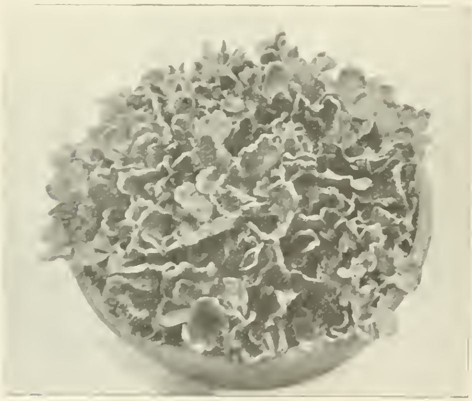
By LEO FARMAR.

THIS little plant is a glorified relative of the Common Liverwort, which is so frequently seen growing on the soil of pots in conservatories.

The genus Monoclea is an interesting exemplification of the evolution of types, forming as it does a connecting link between the liverworts proper (Marchantiaceæ) and the scale mosses (Jungermanniaceæ).

It has always been a matter of contention as to which section it belongs, some botanists placing it in the one while others placed it in the other group.

Professor Duncan S. Johnson, of the Hopkins University, U.S.A., has recently investigated and been able to throw additional light on the subject,* showing beyond doubt that the hepatic plant in question belongs to the order of Marchantiaceæ.



Monoclea Forsteri, Hooker.

Among other important characters, Professor Johnson has discovered that some of the rhizoids, or one-celled roots, have minute tubercles on the inner surface of their cell wall, just as in the Liverworts proper. These tuberculate rhizoids have been overlooked by earlier observers, probably because of their comparative rarity.

The conclusions arrived at are: "That the thallus (the plate-like vegetative portion) of Monoclea is like that of the Marchantiaceæ in gross structure, in the mode of growth and branching, in the type of initial cell, and . . . in the possession of tuberculate rhizoids, as well as thin-walled ones, in which latter character Monoclea differs from all described Jungermanniaceæ."

He further adds that "the facts of vegetative structure referred to strongly indicate a relationship with the Marchantiaceæ and the structure and development of the reproductive organs seem to me to confirm this beyond reasonable doubt."

* "The Development and Relationship of Monoclea." Duncan S. Johnson. *Botanical Gazette*, September, 1904.

Monoclea occurs in Jamaica chiefly on wet rocks and banks in the mountain forests. It may be seen growing most luxuriantly in some of the small depressions near New Haven Gap in the Blue Mountains. It is distributed also in New Zealand and Patagonia, and was first brought home by a naturalist who accompanied Captain Cook on his famous voyage.

The annexed photograph is of a specimen cultivated in the Physic Garden at Chelsea. It is a beautiful object, its delicate dark-green crisp and crested foliage makes it worthy of a place among the choicest of tropical plants.

The Unfolding of the Wings of Insects Emerging from the Pupae State.

By THE REV. ARTHUR EAST.

NOT the least astonishing detail of the marvellous change from a mummified chrysalis, or an unsightly nymph into a winged insect of more or less surpassing beauty, is the manner in which the wings unfold. Looking at the small size of the wing cases in the chrysalis, and contrasting these with the comparatively enormous wings of the perfect insect, it seems impossible that these wings should have been folded into so small a space.

FIG. 1.—Crumpled appearance of the wings upon emergence from the nymph skin.

The process of unfolding is most easily studied in the case of clear-winged insects, as when the wings are clothed with scales the effects, to which the present article is intended to draw attention, are marked. Probably one of the best examples is one of the larger dragon-flies, as the wings are excessively large, and the body, being also bare of scales, shows clearly the part which it plays in the unfolding of the wings.

Fig. 1 shows the appearance of the wings of the great green dragon-fly Æschna Cyanea, when emerging from the nymph skin—little more than a lump of damp, crumpled wing material, greyish in colour, and quite opaque; yet in three hours these insignificant excrescences have to expand to wings considerably longer than the body, and to become perfectly flat and transparent.

How is the unfolding done? It might be supposed, from the fact that such a large number of the heavier insects climb up some support and let the wings hang down as they expand, that the weight of the wings alone would account for the unfolding; this, no doubt, is a considerable help, but it is not sufficient to account for the perfect flatness ultimately obtained, and, moreover, it takes no account of those winged insects which do not hang themselves up, the common gnat, for instance.

Fig. 2.—Insect hanging erect, the wings beginning to unfold.

Fig. 3.—The wings unfolding, the abdomen strongly bowed and much distended.

Fig. 4.—The wings unfolding, the abdomen strongly bowed and much distended.

We may reject, I think, the notion that air is injected, as that would probably cause a certain "puffiness" in the wing, of which there is no sign. I hope to show that the expansion of the wing is effected, in one instance at least, by the injection of fluid, and thus it is a spontaneous action, and entirely under the control of the insect itself.

Now, in the case of the dragon-fly illustrated, the insect, on emerging, hangs head downwards for some little time, for twenty minutes or more; during that time there is not the smallest tendency of the wings to unfold, but directly the second stage of emergence is reached and the insect hangs *right way up*, the wings begin to unfold *at once*; careful observation will show, moreover, that the unfolding is not continuous nor regular as if the creases were simply falling out, but is by fits and starts, and that these irregular movements correspond exactly with great muscular efforts, the segments of the abdomen are contracted, and the impression given is that of someone taking a deep breath and exerting great force. Occasionally there are spasmodic jerks and quiverings, as if to shake loose the folds of the wings. All this time the abdomen is strongly bowed to the exact curve to be occupied by the wing, no doubt to avoid injury to the excessively tender fabric of the wing. It is scarcely possible to doubt that the wings are being forced out of their folds by the muscular energy of the insect.

And that it is fluid which is injected seems to be shown by the fact that if the wing is injured at this stage large drops of emerald green fluid are extruded. An instance of this came under my notice; this particular insect was injured by a grass stem, and the wing did not recover, it remained crumpled and was a complete failure.

Fig. 5.—The abdomen straight, wings nearly dry.

An interesting question remains as to what becomes of this fluid, for at a later stage the wings are perfectly dry. Some of it probably escapes through the pores of the wing, but I am inclined to think that the greater part is withdrawn into the abdomen by an action the reverse of that by which it was injected.

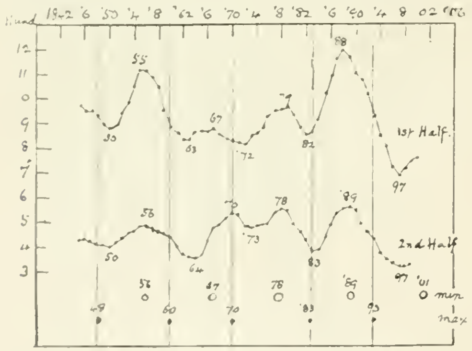
For hours after the wings are perfectly flat and dry the abdomen is greatly distended throughout its whole length, and at intervals during the first day after emergence, fluid is ejected, a drop or two at a time, from the *rectum*. This fluid is perfectly colourless, the green colouring matter being retained in the body of the insect (in this case of Æschna Cyanea or *green* insect). And not for several days does the abdomen become dry and quill-like as when we see the insect on the wing.

Forecasting Seasons.

To the Editors of "Knowledge."

Sirs,—While there are many weather prophets, we seem to have at present little or no sound knowledge as to the character of future seasons, though the cyclical nature of much of our weather, on which fresh light is being thrown, gives reason to hope that this important art of long-range forecasting will one day be achieved, in some measure.

I have lately met with a case in which, I think, one could feel something like certainty regarding a forecast of distant weather; and a forecast sufficiently definite to be useful. The subject is that of the number of frost days at Greenwich in the latter half of 1904 (the average in that half being about 18).



For such inquiries I have been making use of *twice-smoothed curves*. Thus in the present case, the series of numbers of frost days in the latter half, from 1841, is first smoothed in sums of five (grouping 1841-45, '42-'46, and so on). Then these sums are smoothed in the same way. The sum in each case is put opposite the middle member of the group.

The series thus obtained yields the lower curve of the diagram. The upper curve is got in the same way from the number of frost days in the *earlier* half of the year (average 37). Above are indicated the years of maximum and minimum sunspots (without regard to numerical relations), the influence of which, I believe, comes out in these curves; but without entering into this question, or considering how this double smoothing affects the truth of Nature, I would merely call attention to the continuous up and down course of the curves—the rise for several years from the lowest points, and fall for several years from the highest.

The lower curve, ending in 1899, is derived from the actual series ending in 1903. Now, in prospect of the latter half of 1904, we might ask, What will the curve do next, go up or down? Few, probably, would hesitate to say, go up. Then how much will it go up? Here it often seems difficult to form a right conjecture. But in the present case it so happens that a rise of only 1, that is, an addition of one day to the figure for 1899, means that the actual number of frost days for 1904 would be in excess of the average (over 18). I will give the figures from 1890 to make this clear:—

	1890	1891	1892	1893	1894	1895	1896	1897
(*a*)	33	14	22	14	11	14	18	8
(*b*)			94	75	79	65	61	68
(*c*)					374	348	330	314

	1898	1899	1900	1901	1902	1903	1904
(*a*)	[illegible]	18	3	24	10	12	(20)
(*b*)	57	63	65	67	(69)		
(*c*)	314	320	(321)				

(*a*) Actual numbers. (*b*) First smoothing. (*c*) Second smoothing.

The figures in brackets are those for an addition of 1 to the curve-value of 1899, giving the value 20 for (*a*) in 1904; 2 above average.

The actual number proves to be 23; 5 above average.

One could thus safely predict a cold last quarter (frost days over average), and might even estimate the amount of excess approximately.

Doubtless other cases equally clear may be met with.

I am, yours, &c.,

Alex. B. MacDowall.

9, Saltwood Gardens, Hythe.

Wireless Telegraphy.

Those particulars that have been made public of the operations of wireless telegraphy in the Russo-Japanese war have amply served to endorse the soundness of the official view that all the wireless telegraphic installations of a country should be licensed and known, so that in case of war they could be immediately brought under Governmental supervision and control. We are in a position to say that the Government Wireless Telegraphy Bill, which was at first vigorously condemned by more than one electrical engineer as likely to hamper and stifle enterprise, has been found in practice to do nothing of the kind, and is now acclaimed by some who were at first its opponents. The Act is being administered in a broad-minded spirit, and it has been recognised that it operates for the convenience of investigators. "Before the Act," Professor J. A. Fleming has recently said, "we were in the position of a number of people at a public meeting who might by all speaking at once prevent anyone from being heard. The Act regulates and distinguishes our utterances," which is another way of saying that as yet wireless telegraphy has not yet reached the stage when it is secure against violent "interference" from conflicting stations. The same is true in a less degree of ordinary telegraphy along wires, which might be upset by anyone rich enough or malicious enough to set the requisite quantity of electric energy in motion. But it is the fact that wireless messages, if regulated and controlled, can be sent and received without interfering with other wireless stations with which they are not concerned. The next step in wireless telegraphy will be to ascertain the point of origin from which a wireless wave is sent. That can be done to a limited extent now, but it will become more easily accomplished when the measurements of electric waves and the measurements of the sources of energy in, and produced by, wireless telegraphic instruments can be much more accurately measured. The present stage of wireless telegraphy resembles that of cable telegraphy before electricians like Lord Kelvin and Mr. Latimer Clark had shown that accuracy and distance could only be attained by instruments of measured refinement, and that the first step to this *desideratum* was refined measurement.

Star Maps.

In our next issue (May) we propose to commence the series of new star maps. These will be on the system used in Proctor's Atlas, comprising in all twelve maps. The stars will be in white on a dark blue ground so as to stand out clearly, over which will be printed the names of the constellations, letters (and some names) of stars, and R.A. and Declination.

Stellar Brightness and Density.

By J. E. Gore, F.R.A.S.

The absolute brightness of a star, or its so-called "magnitude," depends on three factors—(1), its distance from the earth; (2), its diameter; and (3), its intrinsic brilliancy, or the actual luminosity of its surface per unit of area. The first of these factors—the distance from the earth—has, in a few cases, been determined with considerable approach to accuracy, either by micrometrical observations of comparison stars, or from spectroscopical observations of binary stars. The second factor—the actual diameter of the star—is more difficult to determine, and its measurement has not been satisfactorily accomplished, except in some variables of the Algol type. An approximation to its probable value may, however, be arrived at from other considerations. The third factor—the luminosity of the star's surface—may be inferred—to some extent at least—from the character of the star's spectrum. This luminosity of surface, or intrinsic brightness, as it is also called, probably depends on the mass and density of the star. Two stars may have the same mass, but one may have a large diameter and small density, and the other a smaller diameter and greater density. The difference is probably a function of temperature. And then the question arises, which of the two stars will be apparently the brighter? We know that heat causes a mass of gas to expand, and the greater the heat the greater the expansion. And with a given mass, the greater the expansion the smaller the density will be. This is evident. Hence a star with a high temperature will have a large volume and small density. And it seems highly probable that the higher the temperature the greater will be the luminosity of its surface. From this it would follow that a star with a high temperature would have a large volume and light-giving surface, and also a greater luminosity of surface, and both causes would thus combine to increase its apparent brilliancy. This would not, however, apply to the nebulæ, but only to bodies, like the stars, which have consolidated to a certain extent.

It is now usually admitted that stars with the Orion type of spectrum (B, Pickering), such as Bellatrix (γ Orionis), δ, ϵ, and ζ Orionis, are—with the possible exception of the "Wolf-Rayet," or bright line, stars—the most luminous among the brighter stars. Next to these come stars with the Sirian type of spectrum (A, Pickering), followed probably in decreasing order of surface luminosity by stars of the second (or solar) type, and then by the third and, perhaps, the fourth type stars. The "Algol variable" U Ophiuchi has a spectrum of the Orion type, and some of the other "Algols," such as Algol itself, λ Tauri, and V Puppis, show a spectrum intermediate between the B and A type. These will be considered further on.

The probably great luminosity of stars with the Orion type of spectrum is shown by the fact that Sir David Gill finds that the parallax of Rigel is almost certainly not more than the hundredth of a second of arc, and yet it is one of the brightest stars in the heavens; seventh in order of brightness, according to the Harvard photometric measures. At the vast distance indicated by this minute parallax our sun would be reduced to a star of about the tenth magnitude, and would, therefore, be invisible even with a binocular field glass. Rigel is, therefore, about 7,800 times brighter than the sun would be if removed to the same distance. It has a small companion of the eighth magnitude, but as the pair have not yet been proved to be a binary (although the companion itself, which is double, probably is), we cannot determine its mass. But it is evident that it must be a body of enormous size and great luminosity of surface to shine as brightly as it does at such a vast distance from the earth—over 300 years' journey for light. Comparing it with Sirius, whose mass and parallax have been well determined, I find that the mass of Rigel is probably about 20,000 times the sun's mass.

The great brilliancy of stars with the Sirian type of spectrum is shown by Sirius itself, the distance of which is now well determined. From its apparent brightness and parallax I find that Sirius is about 31.6 times brighter than the sun would be at the same distance. From the orbit of its satellite Dr. See finds the mass of the bright star to be 2.36 times the sun's mass, and from this it follows that its real brightness is about 18 times greater than that of the sun in proportion to its mass. Its spectrum shows that it is probably at a higher temperature than our sun. Its volume is, therefore, probably larger, and, as Dr. See says, there "is some reason to suppose that Sirius is very much expanded, more nearly resembling a nebula than the sun." But here the question suggests itself, Is its greater brilliancy due to its larger volume, and, therefore, smaller density, or to its greater surface luminosity, or to both causes combined? As it is 31.6 times brighter than the sun, a diameter equal to the square root of 31.6, or 5.62 times the sun's diameter, would give the necessary brightness, *if* the surface luminosity of Sirius and the sun were the same. Assuming this for a moment, I find that with a diameter of 5.62 times the sun's diameter—or about five millions of miles—its volume would be 177 times the sun's volume, and its density only 0.019 (water = 1). This seems improbable, judging from the known case of Algol, which has a much higher density than this. We may, therefore, conclude, I think, that the great brilliancy of Sirius is probably due to both causes combined—namely, a somewhat larger volume and a greater luminosity of surface than the sun, both probably due to its higher temperature. If we assume its density to be the same as that of Algol, say 0.34, we have the diameter of Sirius about 1,860,000 miles, and its luminosity about seven times that of the sun.

The well-known double star, Castor (a Geminorum), has a spectrum of the same type as Sirius. The orbit is rather uncertain, but Dr. Dobeeck has recently found a period of 346.82 years, with a semi-axis major of 5″.756. A doubtful parallax of 0″.198 was found by Johnson. From these data the mass of the system would be only 0.2042 that of the sun. In 1894 the fainter component of the pair was found by Bélopolsky to be a spectroscopic binary with a period of about 2.98 days, and an orbital velocity of 20.7 miles a second, the companion being relatively dark. If we assume that the components of the spectroscopic pair are equal in mass I find that its mass would be 0.0911 of the sun's mass. Now as the brighter star of the *visual* binary is one magnitude brighter than the companion, its mass would be—if of the same surface luminosity—four times that of the other, or 0.3644. Hence the total mass of the system would be 0.0911 + 0.3644, or 0.4555 of the sun's mass. We may, therefore, conclude from the spectroscopic observations that the mass of the system is comparatively small. Assuming the masses found above, namely 0.0911 and 0.3644, the areas of their surfaces would be 0.2024 and

0.5102, or a total surface of 0.7126. Now the mass of Sirius being 2.36, its relative surface would be—if of the same density as Castor—1.7726. Hence the surface of Sirius would be 2.487 times that of the combined surfaces of Castor's lucid components. But Sirius is 3.10 magnitudes (1.58+1.58) brighter than Castor. From these data I find that the parallax of Castor would be about 0''.136, which does not differ widely from the result found by Johnson. The brighter component of this interesting pair has recently been found at the Lick Observatory to be also a spectroscopic binary, but the period has not yet been determined. The fact that *both* components are spectroscopic binaries makes Castor one of the most remarkable objects in the heavens.

For δ Equulei, a binary star with the very short period of 5.7 years, Hussey finds from spectroscopic measures a parallax of 0''.071, and a combined mass of 1.89 times the sun's mass. He says, "The components of the pair are slightly unequal in brightness, and, perhaps, also in mass. One may be as massive as the sun, but it cannot much exceed it."* The parallax found by Hussey would, I find, reduce the sun to a star of 5.81 magnitude, and as the photometric magnitude of δ Equulei is 4.61, we have the star 1.20 magnitude, or three times brighter than the sun. Assuming that the masses of the components are 1.00 and 0.89 (as suggested by Hussey), I find that if the surface luminosity of each were equal to that of the sun, the combined light of the two components would be 1.9247, or nearly twice the sun's light. The star's spectrum is of the type F, probably indicating a somewhat brighter sun than ours. The difference in the results found above is, therefore, not inconsistent with the parallax found by Hussey. A comparison with Procyon is also confirmatory of Hussey's result.

Let us now consider the case of the bright star Procyon, which has a spectrum F 5 G, or intermediate between that of δ Equulei and the sun. The parallax is about 0''.325, and the mass of the system is, therefore, from Dr. See's orbit of the satellite, 3.627 times the sun's mass, that of the bright star being about three times the mass of the sun. At the distance indicated by the parallax the sun would, I find, be reduced to a star of 2.51 magnitude, and as the magnitude of Procyon is 0.48, we have the star 2.03 magnitude, or 6.487 times brighter than the sun. As, however, the mass of Procyon is three times the sun's mass, the star should be—if of the same density and surface luminosity, 2.08 times brighter than the sun. Hence it follows that Procyon is really $\frac{6.487}{2.08}$ or 3.1 times brighter than our sun in proportion to its mass. This may be due either to a larger size, and, therefore, less density than the sun, or to a greater luminosity of surface per unit of area. Probably both causes combine to produce the increased brilliancy, and the result seems to agree well with the star's spectrum, which probably indicates a slightly more luminous sun than ours.

The binary star 70 Ophiuchi has a spectrum intermediate between the second and third types (K, Pickering), probably indicating a rather fainter body than our sun. An orbit computed by Dr. See, combined with a parallax of 0''.16 found by Schur, gives a combined mass of 2.94 times the sun's mass. This parallax would reduce the sun to a star of about 4.05 magnitude, and as the photometric magnitude of 70 Ophiuchi is 4.07, the star is about equal to the sun in brightness. But as the star's mass is 2.94 times the sun's mass, the star should be, if exactly comparable with the sun, about twice as bright. Hence it would follow that the surface luminosity of the star is less than that of the sun—about one-half, and the spectrum indicates that this is probably the case.

Let us now consider the case of the "Algol variables." For Algol itself, Vogel found from spectroscopic observations the diameter of the bright star to be 1,074,000 miles, with a mass of 4-9ths of the sun's mass, and for the "dark" companion a diameter of 840,000 miles and a mass of 2-9ths of the solar mass. This result was obtained on the assumption that both components are of equal density—about one-third that of water. But that a dark body of such large size should have the same density as a bright body, like Algol itself, seems highly improbable. The density of the planet Jupiter—which has some inherent heat of its own—is about 1.30, and that of Saturn about 0.68. We should, therefore, expect that a large body, like the companion of Algol, would have a considerable amount of inherent light, or surface luminosity. Let us see what brightness it *could* have without sensibly affecting the observed light variation of Algol. That is, what is the maximum brightness which the companion might have without producing a secondary minimum of light when hidden behind the disc of the bright star? Chandler finds for Algol a parallax of 0''.07. The sun placed at the distance indicated by this small parallax would be reduced to the light of a star of 5.84 magnitude, and the photometric magnitude of Algol being 2.31, it would be 3.53 magnitude, or nearly 26 times brighter than the sun. Let us assume that the companion has this magnitude of 5.84—which it might have without the spectroscope showing it. Then when in the course of its orbital revolution round Algol it is hidden behind the bright star, the normal light of Algol would be reduced by its 27th part. This means that the light of Algol would be diminished by about 0.04 magnitude, or from 2.31 to 2.35, a difference which would not be perceptible to the naked eye, and could hardly be detected with certainty by even the most delicate photometer. The spectrum of Algol is, according to Pickering, B 8 A, that of Sirius being A. Comparing the two stars, and assuming the surface luminosity to be the same, I find a parallax of 0''.11 for Algol. This would reduce the sun to a star of 4.84 magnitude, and if we suppose the companion to have this brightness, then Algol would be about 10 times brighter than its companion, and when the latter is hidden behind the brighter star, the light of Algol would be reduced from about 2.31 to 2.41, and even this difference could hardly be determined with certainty. It would seem probable, therefore, that the companion of Algol has some inherent light of its own, and is not quite a "dark body." Assuming a parallax of 0''.07, I find that the surface luminosity of Algol itself would be 17 times that of the sun.

In the Algol system the components are separated by a distance of over two millions of miles (between their surfaces), but in some of the "Algol variables" the components revolve in contact, or nearly so. Some have both components bright. Examples of this type of variation are β Lyræ, U Pegasi, V Puppis, X Carinæ, and RR Centauri. The characteristics of the light fluctuations are, according to Dr. A. W.

* *Astrophysical Journal*, June, 1903.

* It has been recently found that a difference in brightness of two magnitudes between the components of a spectroscopic binary is sufficient to obliterate the spectrum of the fainter component.

Roberts*, as follows: (1) "continuous variation, indicating that the component stars are in contact," and (2) two maxima and two minima, showing that the components are both bright bodies. The variation of β Lyræ is well known. It is not usually considered as an Algol variable, but it now seems probable that it should be included in that class. Myers finds that β Lyræ probably consists of two ellipsoidal components revolving nearly in contact, the mass of the larger component being 21 times the mass of the sun, and that of the smaller $9\frac{1}{2}$ times the sun's mass. He thinks that the mean density of the system "is comparable with atmospheric density"—that is, that they are "in a nebulous condition." If this conclusion is correct their diameters must be enormous. Taking the density of atmospheric air as 814 times less than that of water, I find that the larger component would have a diameter of about 25 millions of miles, and the smaller about 19 millions. The parallax of β Lyræ has not been ascertained, but supposing it to be about one-hundredth of a second, the sun would be reduced to a star of about the 10th magnitude. The maximum brightness of the star is about 3.5 magnitude. It would, therefore, be—with the assumed parallax—$6\frac{1}{2}$ magnitudes, or about 400 times brighter than the sun. From the diameters found above, the combined surfaces of the two components would be 1,332 times the sun's surface. Hence their surface luminosity would be less than one-third of that of the sun. This would agree with Homer Lane's law, by which a gaseous body gains in heat as it consolidates, and β Lyræ is probably in a very early stage of stellar evolution. If the parallax is larger than assumed above, the surface luminosity would be still less.

Another remarkable star is the Southern Algol variable, V Puppis (Lacaille 3105). Both components are bright. The spectrum of the brighter component is, according to Pickering, of the "Orion type," B 1 A, and that of the fainter B 3 A. The period of light variation is 1.454 day. The spectroscopic measures show that the relative velocity is about 380 miles a second. The combined mass of the system is, therefore, about 70 times the sun's mass. As the star is variable in light, the plane of the orbit must necessarily pass through the earth, and the accuracy of this result for the mass is, therefore, certain. This great mass, and the star's magnitude—about 4.50, shows that it must be at an enormous distance from the earth. According to Dr. A. W. Roberts, the density of the components cannot exceed 0.02 of the sun's density, and he finds that they "revolve round one another in *actual contact*." Assuming this density and a mass of 35 times the sun's mass for each component, I find that the diameter of each would be about $10\frac{1}{2}$ millions of miles. Now, comparing it with Algol, of which the diameter and mass are known, and assuming the same surface luminosity, I find that the parallax of V Puppis would be about $0''.0018$, or a light journey of about 1,800 years. As it lies in or near the Milky Way, it may possibly be one of the larger stars of the Galaxy. The parallax found above would indicate that the star is about 5,000 times brighter than our sun would be if placed at the same distance. The star is thus a very remarkable and interesting object. Its mass is very large, its density is very small, and the intrinsic luminosity of its surface is very high. Its distance from the earth is very great. Its orbital revolution is very rapid, and the variation of light is small and very regular. It is, in fact, one of the most remarkable objects in the heavens.

* *Monthly Notices*, R. A. S., June, 1903.

CORRESPONDENCE.

Creation of Species.

To the Editors of "Knowledge."

Sirs,—Replying to Mr. Herbert Drake's letter in your March number, the strong hold which the "dogma of constancy of species" had obtained amongst theologians of that period is illustrated by the fact that Robert Chambers published "Vestiges of the Natural History of Creaton" anonymously, in order to avoid involving the firm with which he was connected in theological controversy, and the storm which followed Chas. Darwin's "Origin of Species" shows that this precaution was justified.

From the active part taken by Bishop Wilberforce and other prominent Churchmen of the time in this controversy, it would appear that the objections taken to the dogma can scarcely be dismissed as "popular prejudice or superstition," as suggested by Mr. Drake. There can be no doubt that the strong belief in this dogma held by the majority of the members of the churches, whether popular prejudice or not, delayed the advent of the theory of evolution.

One grave objection taken to the theory of evolution was that it did not accord with the literal reading of the first chapter of Genesis. This was also an important objection raised in the heated discussion which followed the publication of "Essays and Reviews," in which discussion many of our Bishops took a leading part.

J. C. Shenstone.

"Common" as a Scientific Term.

The word "Common" is a useful one for ordinary use, but as a scientific term it has many disadvantages. Not the least of these is its ambiguity. We may say "the common snipe," or "the snipe is common there," or "the snipe is common to several countries," and use the word thus in three different ways, and not be sure that we shall be perfectly understood in any of them. I had always myself understood the expression "the common snipe" to mean the snipe that is ordinarily meant by the word snipe without qualification. But Mr. F. G. Aflalo ("Knowledge" vol. 2, p. 52) takes it to mean the "prevalent" species of that bird.

With regard to the Latin equivalents, *communis* in either of these senses simply is not Latin. It can only, in that language, mean common to two or more places. While *vulgaris* means "ordinary," "as used by uneducated people."

In this latter sense, which is I think the one in the minds of most people, one could well speak of "The Common Dodo," so as to distinguish the *Didus Ineptus* of Mauritius from the less well-known Didine birds of Rodriguez and Réunion. Yet Mr. Aflalo would deny its appropriateness to any species which is growing extinct.

Another objection to *vulgaris* is that it connotes the idea of popular error; it would be more appropriately used to stigmatise an incorrect title, than as a scientific distinction.

To introduce the term "common sense" in this connection seems like making "confusion worse confounded." We are given three derivations of the expression. First, a man's five senses were supposed to be the five avenues of one common organ, hence styled "the Common Sense." Next, there is the meaning of "the ordinary judgment of mankind." And then there is the philosophical definition, which makes it equivalent to the first principles of belief which ordinary men accept. None of these have anything to do with the Latin *communis sensus*, or the feeling common to all men as to what is right and proper. In actual use these various ideas are so confused that one can rarely meet two people to whom the word conveys the same meaning. I remember a scientist telling me that his common sense told him that miracles do not happen. I pointed out to him that whether that were an argument for or against miracles depended on the meaning attributed to "common sense." Once I heard, shortly after one another, two preachers, one of whom denounced, and the other pleaded for, the use of common sense in religion. They both meant the same thing, but used the term in contrary meanings! We need to be well on our guard against such a doubtful expression.

Verwood, Wimborne, March 13. Herbert Drake.

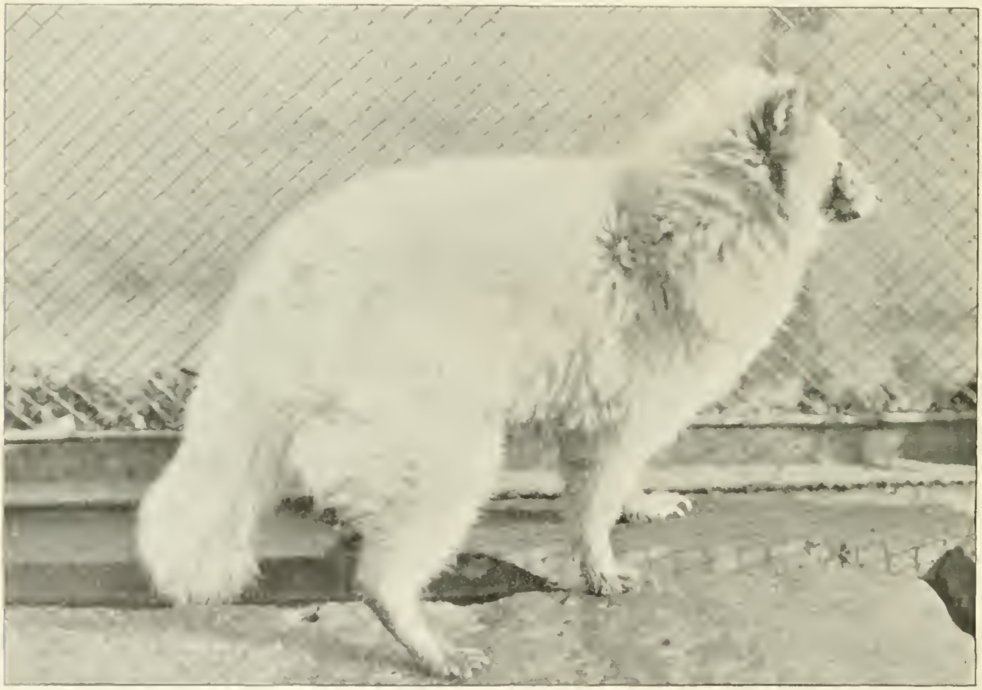
A White Raccoon Dog.

A New Species.

By EMILE GUARINI.

THIS strange specimen of dog was obtained by Captain Golding in Nagasaki, Japan, of a native dealer in live animals, who was unable to give its history, and could only state that it came from the northern portion of Japan. It bore a slight resemblance to an immature Arctic fox, but it was at once apparent that the creature was not a fox, and during the 15 months it has lived in the Zoological Park, of New York, it has not undergone any noteworthy change in pelage, nor has it perceptibly increased in size. It therefore seems conclusive that the creature is adult, and that its colours are constant throughout the year. An examination of its external characters revealed an unmistakable resemblance to the raccoon dog of Japan and China, but it is not an albino individual of this well-known species. There appears to be no escape from the conclusion that this specimen represents a species hitherto unknown.

In general form this animal resembles a sharp-nosed raccoon. Its weight is $7\frac{1}{2}$ pounds, its length of head and body 21 inches, the height at shoulders being 10.29 inches. The tail is 6.29 inches to end of vertebræ, and 8 inches to end of hair. The back is highly arched, its head is carried rather low, and its tail has a very raccoon-like droop. The feet are small and delicately formed, and the front feet in particular are short and weak. Although the claws are long, they are slender, remarkably straight, and have little strength, either for offence or defence. The ears are short, and in shape most nearly resemble those of the Arctic fox. As a whole, this animal is not physically robust, nor is it vicious in temper. Its teeth are small and weak, and it is poorly equipped for self-preservation. It requires a home that is not overrun by bears, wolves, foxes, &c., and very probably it inhabits moist lowlands rather than dry and rugged mountains. The feet are very thinly haired as if this creature had been specially fitted for life in swamps and tundras, where frequent wading in water is necessary.



White Raccoon Dog.

On the neck, body, tail, and thighs the pelage is dense and fine, and consists of two coats. On the upper surface the inner coat is very fine and woolly, and about one inch long. The outer coat is two inches long, straight, and of coarser texture, as is usual in a rain-coat. The hair on the tail is abundant, but ends abruptly at the tip, like a tail artificially shortened. The pelage on the lower half of each leg is exceedingly scanty. On the abdomen the pelage is about one-half the length of that on the upper surface, and consists chiefly of the fine woolly under-fur. Excepting upon the feet and lower half of the legs, the pelage is like that of a small Arctic fox. The entire neck, body, legs, feet, and tail are pure white. On each side of the head is a large and conspicuous triangular patch of blackish-brown hair, the top of the muzzle is white, and the upper lip shows a light-coloured blending of brown and white. The forehead is white; the ear is conspicuously dark, the edge being quite black.

NOTES

ASTRONOMICAL.

Secular and Seasonal Changes on the Moon's Surface.

FOR some years past Professor W. H. Pickering has been engaged in a series of special studies of the lunar surface. The work has been undertaken in connection with the Astronomical Observatory of Harvard College, and a full account of the results obtained will be found in volume 53 of the "Annals" of that institution. A short *resumé* has recently been presented in *Nature* over the signature of Professor Pickering.

Briefly summarised, it may be stated that the evidence of structural change on the visible hemisphere of our satellite has been suspected from time to time by various eminent selenographers, notably by Mädler, Schmidt, Webb, Elger, and Niesen. In more recent years the work of Professor Pickering during a long series of special observations in Peru, Jamaica, and California, has led him to the conclusion that physical changes do occur upon the moon, and that they may be classified under three heads, due respectively to (1) volcanic action, (2) formation and melting of hoar-frost, (3) growth and decay of vegetation.

The first class of phenomena has its most forcible example in the crater Linné, which, according to Lohrmann, Mädler, and Schmidt, prior to 1843, had a diameter of between four and seven miles, whereas its present diameter is three-quarters of a mile. A new crater has also been announced in the vicinity of the well known formation Hyginus. Again, the floor of the crater Plato has repeatedly furnished new formations under telescopic examination at various times. Pickering's latest observations show the existence of a crescent-shaped bank, about six miles long by one or two miles broad. Reference to the maps made by A. S. Williams during the period 1879-90, indicates that no object similar to that now existing was to be seen at that time; but the maps themselves show that slight variations were apparent at different epochs of observation.

Considering now the second variety of changes, there are numerous tracts on the moon's surface which exhibit variations in light and shade, which from their character lead to the assumption that they are due to the alternate condensation and volatilization of hoar frost. Professor Pickering especially draws attention to the evidences of aqueous erosion on the central peaks of Theophilus and Eratosthenes, and further considers that the strongest evidence for the former presence of water lies in the dried-up river-beds, of which the best example is to be seen on the eastern slopes of Mount Hadley, at the base of the Appenines. Another, discovered only in the summer of 1904, lies about 60 miles due south of Conon. Still more positive, however, is the evidence the author gives of personal observations of the periodical changes in the craters Messier and Messier A, according to the progress of the lunar day—changes which he asserts may be followed with a telescope of 4 inches aperture under good atmospheric conditions.

The third class of phenomena, possibly due to the growth and decay of vegetation, are stated to be more conspicuous than the effects produced by the two former causes. Reproductions are given of photographs obtained by Professor Pickering in the island of Jamaica in 1901, showing undoubted evidence of changes in the crater Eratosthenes, progressing very regularly with the age of the moon. Every precaution has been taken to exclude effects due to varying angles of lighting, and it remains quite certain that growths of dusky matter have taken place. As we have no knowledge of any mineral matter which could produce this appearance, it seems proper to ascribe it to vegetable growth.

Law of the Sun's Rotation.

Professor N. C. Duner, of Upsala, has within the last few years been engaged in a series of observations for the determination of the Sun's rotational velocity at different heliographic latitudes. The observations were made by determining the linear velocity at various points on the Sun's limb, by measures of the displacement of spectrum lines in the line of sight. In the latest list given he brings together results obtained from various determinations during the period 1887-1901. The following is a summary of the values found, taking zones of latitude of 15°.

Heliocentric latitude. ρ	Rotation Velocity at Limb. v	No. of Observation η	$\xi \cos \rho$	Angle of Daily Rotation. ξ
	K.M.		Degrees.	Degrees.
0·4	+ 2·08	183	14·770	14·77
15·0	+ 1·97	180	13·989	14·48
30·1	+ 1·70	184	12·072	13·95
45·0	+ 1·27	181	9·018	12·75
60·0	+ 0·81	183	5·752	11·50
75·0	+ 0·39	184	2·769	10·70

New Determination of Solar Constant.

Monsieur A. Hansky has recently published an interesting account of a series of determinations of the solar constant by actinometric observations on the summit of Mont Blanc. As given by various observers, this important quantity has been assigned many values, of which the following are the more important:—

Pouillet	1·763
Violle (Mt. Blanc)	2·54
Crova (Mt. Ventoux)	2·83
Langley (Mt. Whitney)	3·068
Savelieff	3·47
Angstrom (Peak of Teneriffe)	4·00

The two latter values are obviously too high in view of the more recent refined determinations. Later determinations with the bolometer by Langley gave the revised value of 2·54 as the more probable value.

M. Hansky's observations were made on the Mont Blanc station during the years 1897, 1898, and 1900, giving the mean value of 3·29 as his final result. The series of 1900 were made under specially favourable conditions, and full details are given of that section. During twelve days' sojourn there he secured five actinometric curves, and numerous direct determinations of the solar thermal radiation, all of the observations being obtained with Crova's actinometer. From July 23 to 28 the weather was extremely fine, but the temperature high. The air was almost quite calm, but the aërial currents from the valley were evidently strong, as indicated by the formation of cumuli above the summit of the mountain. The hygrometric state at the summit was 70 per cent., indicating a vapour tension of about 1·2 mm.

The polarisation of the sky was about 0·50, and never exceeded 0·67; the colour of the sky was normal blue; barometric pressure varied from 426 to 430 mm.

The actinometric curves were very regular during the morning and evening hours, but showed strong depressions a little before and a little after midday (from 9 h.—1 h.), exactly as Crova had already found at Montpellier and Mont Ventoux. This depression may in part be attributed to the ascending air currents from the valley carrying with them large quantities of aqueous vapour, thus exerting considerable absorption of the calorific rays.

* * *

Seventh Satellite of Jupiter.

A telegram received from the Kiel Centralstelle on February 28, too late for inclusion in our last issue, announced the discovery of yet another satellite of the planet Jupiter, presumably by Professor Perrine, although the authorship was not mentioned.

The new satellite was stated to be of the 16th stellar magnitude, and its position when measured was

Position angle from Jupiter = 62° } D.
Distance = 21' } 1905, February, 25·6

The daily motion was determined to be 60″ of arc in a south-easterly direction.

Professor Campbell, in a later confirmation of the above, informs us that the discovery was made by Professor Perrine with the Crossley reflector of 36 inches aperture, and that the object had been under observation since January 2. The apparent motion of the satellite is direct, and the provisional elements indicate an orbit considerably inclined to the ecliptic.

CHEMICAL.

By C. A. Mitchell, B.A. (Oxon.), F.I.C.

The Electric Bleaching of Flour.

A new electric process of producing an extremely white flour has recently been adopted in Paris. Specimens of the flour before and after the treatment have been examined by M. Balland, who finds that although the whiteness is undoubtedly increased, yet the flavour and odour are not so good as before. This is shown by the analyses to be due to a partial decomposition of the wheat oil, to which flour owes its aroma, and the flour increases greatly in acidity through this decomposition. In fact the process is essentially an artificial ageing accompanied by the usual whitening that occurs in old flour.

* * *

Radio-Active Substances in Natural Waters.

The water and the gases of the hot springs in Wiesbaden have been shown by Dr. Henrich to be strongly radio-active, whilst the stalactites also exhibited the same phenomenon. The water could be rendered nearly inactive by boiling it so as to expel the dissolved gases, but the stalactites retained their radio-activity on keeping. The element helium, which is known to be formed from radio-active substances, has been identified by M. C. Mouren in the gases from 12 French mineral springs, some of which contained 50 times as much as the others. Helium has also been detected by Sir James Dewar in the gases from a mineral spring in Bath.

* * *

The Gum Disease of the Sugar Cane.

The Australian sugar cane suffers from a disease which is characterised by the formation of a yellow gum within the vascular fibres of the plant. It was first described in 1893 by Mr. Cobb, who attributed it to a species of bacterium which he isolated from the gum, but his attempts to inoculate healthy plants with the disease were inconclusive. Professor E. Smith, however, has recently prepared pure cultivations of the micro-organism which he terms *pseudomonas vascularum* (Cobb), and has successfully inoculated common green sugar canes with them so as to produce all the symptoms of the Australian gum disease. The acidity of the juice appears to have considerable influence upon the susceptibility of the plant to infection, for two other varieties of sugar cane, Louisiana No. 74 and the common purple cane, with a much more acid juice, offered great resistance to the attack of the *pseudomonas*. The practical remedy of planting varieties of cane that are not readily affected has already given good results in the sugar plantations.

* * *

The Use of Specific Sera in Chemical Analysis.

One of the most difficult problems in analytical chemistry is to distinguish between the flesh or blood of different animals, and until recently the tests employed left much to be desired. In 1899, however, it was discovered by M. Borget that when a rabbit was inoculated with the serum of cow's milk its own blood serum became so modified as subsequently to give a precipitate when added to the serum (whey) of any cow's milk. This discovery was shown by Dr. von Rigler (1902) to be capable of extension, and that when rabbits were inoculated with extract or broth of a given animal the serum from their blood would then give a precipitate with extracts of the flesh of that particular animal, but not with those of any other animal. Thus sera rendered specific to horseflesh would not react with extracts of beef venison, pork, &c. A still more important development of this idea seems likely to effect a complete revolution in the methods of examination in criminal cases. For when human serum is injected into a rabbit or guinea-pig their sera become specific for human blood serum, and the test can be applied even in the case of a blood stain several months old. In a recent criminal trial in France the prisoner asserted that certain stains were caused by rabbit's blood. Sera specific for rabbit's and human blood were therefore prepared, and when it was found that a saline extract of the stain gave no pronounced reaction with the former, while it did so with the latter, the chemical experts considered that they were justified in reporting that the stain was certainly not rabbit's blood, but in all probability consisted of human blood. The nature of the specific substances in the sera is not known, but they are probably albuminous derivatives formed by certain constituents in the rabbit's cells in their attempt to expel the intruding substance. They can be precipitated and dried at a low temperature in a vacuum, and the *præcipitines* thus obtained only require the addition of water to produce a solution acting almost as readily as the fresh specific serum, and have also the great advantage that they can be kept in the dark for months without undergoing any change.

GEOLOGY.

Conducted by Edward A. Martin, F.G.S.

A Well-Boring at Holborn.

Water to the extent of 3000 gallons per hour is being obtained from a new well at the Birkbeck Bank, Holborn, E.C. The strata passed through in the boring is as follows, kindly supplied by Mr. Heywood, of the firm of Messrs. Robert Warner and Co.:—

	FT.	
Alluvial	12	Basement.
	15	Ballast.
London Clay	85	London clay.
	15	Coloured clay.
Oldhaven	7	Sand and water.
Woolwich and Reading Beds	15	Coloured sandy clay and pebbles.
	$2\frac{1}{2}$	Sand pebbles and oyster shells.
	4	Sand and small pebbles.
Thanet sand	$22\frac{1}{2}$	Thanet sand and water.
Chalk	284	Chalk.

The well is sunk 5 feet into the chalk (5 feet diameter), lined with brickwork and iron cylinders; then an open sinking in the chalk for about 30 feet, and a boring in the bottom of the well to 462 feet. It will be seen that there is a total thickness of 178 feet above the chalk.

* * *

A New British Tortoise.

An interesting find is recorded from the lower Headon Beds of Hordwell, Hants, in the shape of bones of the carapace and plastron of a new species of tortoise. It has been given the name of *Nicoria Headonensis* by Mr. R. W. Hooley, F.G.S. The bones were scattered over a space of about four square feet, the broken edges of the entoplastral and right hyoplastral being found sticking out of the face of cliff. The specimen has been referred to the *Testudinidæ*, genus *Nicoria*, this being the first record of the genus from England. To-day it is found in the East Indies and in South America.

* * *

Maryland Miocene Formation.

The two new volumes of the Maryland Geological Survey, dealing with the Miocene deposits of that State, are models of what Government publications should be. Comparisons of these volumes with those issued by our own Survey are forced upon our notice, and we can only hope that in the course of time our own Government may be induced to make larger grants towards our half-starved Geological Survey. Of the two volumes now to hand, one contains over 500 excellently-printed pages of text, whilst the second volume contains 125 full-page engravings of fossils. The Miocene deposits of Maryland have long been known to geologists for the rich faunas

which they contain, and collections brought therefrom hav for many years enriched museums all over the world. Considering the barrenness of our own country as regards this formation, it is interesting to note that the Maryland Miocene shows a greater diversity of species than does the Eocene. The former are known as the Chesapeake group, from the superb sections seen on the shores of Chesapeake Bay. The group is divided into three well-defined formations, called Calvert, Choptank, and St. Mary's. They lie uncomfortably upon the Eocene, overlapping them along their western border. Beds of nearly pure diatomaceous earth, of between 30 and 40 feet thick, are met with in the lower portions of the Calvert formation; whilst the Chesapeake group, as a whole, is characterised by the great masses of molluscan shells which it contains, these forming sometimes so large a proportion as to produce nearly pure calcareous strata. The State Geologist (Mr. William Bullock Clark) and his assistants are to be congratulated upon the thoroughness and excellence of their work.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Ivory Gull in Fife.

An Ivory Gull (*Pagophila eburnea*) is reported, by the "Annals of Scottish Natural History," to have been seen in Largo Bay on Sept. 15. It flew past the observers so closely that "an excellent view of the pure white plumage, black eye, and yellow bill" was obtained.

* * *

Pied Flycatcher in Fife.

Two examples of this rare visitor to Scotland are reported in the "Annals of Scottish Natural History," as having been seen in Fife during May, 1904—one at Gilston on the 8th and one at Largo on the 12th. Both left on the 14th of this month.

* * *

Nutcracker in Kent.

At the meeting of the British Ornithologists' Club held on January 18, Dr. N. F. Ticehurst exhibited a nutcracker (*Nucifraga caryocatactes*), which had been killed on the 14th of that month by a gamekeeper at Benenden, in Kent. It proved, on dissection to be a male. This makes the fourth occurrence of this bird in Kent.

* * *

Sabine's Snipe in Anglesey.

A melanistic variety of the common snipe, known generally as "Sabine's snipe," was killed in a turnip-field in Anglesey on January 21.

* * *

A White Water Rail.

Mr. R. Patterson, in the *Irish Naturalist* for February, records the fact that a pure white water rail has just been shot at Seaforde, Co. Down. While the beak retained its normal colour, the legs and feet were of a pale pink orange. The bird was in splendid condition, and weighed $5\frac{1}{2}$ ozs.

* * *

Little Auk at Portmarnock.

Mr. J. Turnbull, in the *Irish Naturalist* for February, reports the fact that a little auk (*Mergulus alle*) was picked up in an exhausted condition in a field at Portmarnock on November 27. This makes the sixth occurrence of this bird in Co. Dublin.

* * *

The Pacific Eider.

In our notice in February of the occurrence of the Pacific Eider (*Somateria V-nigra*), we inadvertently described it as having been shot at Scarborough. We learned, too late, that as a matter of fact it was killed at Graemsay, Orkney, in the early morning of December 14, by a wildfowler named George Sutherland, and was sent, with some common eiders, to a dealer at Scarborough.

The Migration of Birds.

We are glad to say that the British Ornithologists' Club has just appointed a Committee to inquire into the "migration of birds within these islands." The need for such an inquiry is now most necessary since this work has been relinquished by the British Association.

For the present observations are to be confined to the "arrival in England and dispersal through England and Wales of the thirty or so strictly migratory species which winter abroad and nest fairly commonly in England and Wales." Later, it is proposed to considerably extend the range of these observations.

Thus it is suggested that the services of lighthouse keepers should be enlisted, subject to the permission of the Master and Elder Brethren of the Trinity House. The keepers in question are to be asked to fill up schedules containing information as to the birds observed or captured at the lighthouses, and to forward the wings and feet of birds killed at the lamps. In short, they are to continue the work which has been so successfully carried on during the last few years by the Committee of the British Association.

Besides these helpers, other observers from a large number of centres in England and Wales are to be asked to co-operate, and to fill up similar schedules.

The fact that Mr. Eagle Clarke has promised to give his advice and help should go far to ensure success for this most valuable work.

* * *

The Study of Hybrids.

Hitherto the value of hybrid birds, from a scientific point of view, has been open to question, inasmuch as the parentage of the particular hybrids can never be positively demonstrated. Even when this parentage is known no great value can be attached to the fact. This is by no means the case, however, with the experiments now being carried out by Mr. J. L. Bonhote in his aviaries at Ditton Hall, Cambridge.

As a basis of operations he selected the Mallard, Pintail, Spotted-bill (*anas pœcilorhyncha*) and New Zealand Duck (*anas superciliosus*). The most interesting of the results so far obtained are those of the hybrids Mallard × Spotbill × Pintail. The offspring of this complex mixture of blood were divisible into two races—a light and a dark race. Of these the drakes in full plumage favoured the Mallard and Pintail about equally, whereas in eclipse plumage they resembled the Spotbill. The dark females have so far proved infertile, but this is not the case with the dark drakes when mated with pure bred birds of either species.

Though neither the Spotbill nor New Zealand Ducks have an eclipse plumage, when crossed with other species this peculiar phase is always assumed. Another interesting point which Mr. Bonhote's experiments have brought out is the fact that while some of these hybrids resemble the parent forms, others assume characters belonging to species which have had no part in their ancestry; or they develop features entirely new, that is to say, which can be referred to no known wild species.

The offspring of the light forms prove either as light as, or lighter than, their parents. As these experiments are still in progress it is probable that very substantial additions to our knowledge of hybridization will result.

* * *

A New British Bird.

At the meeting of the British Ornithologists' Club held on March 15 an adult male of the Snowfinch (*Montifringilla nivalis*) was exhibited by Mr. M. Nicholl. This bird was shot at Rye Harbour, Sussex, on February 22, and is the first recorded occurrence of this species in these islands. The Snowfinch bears a very striking resemblance to the Snowbunting, and is a native of the mountains of Southern Europe extending eastwards to Palestine.

* * *

An Albino Shag in Orkney.

The *Field*, March 4, contains an account of a true albino of the Shag (*Phalacrocorax graculus*), which was obtained towards the end of December last near Stromness, Orkney. A similar example, according to the same authority, was obtained at Mid Yell, Shetland, on February 27, 1884.

ZOOLOGICAL.

By R. Lydekker.

An Asiatic Ocelot.

The small marbled cats known as ocelots (*Felis pardalis*) have hitherto been regarded as an exclusively New World type, where they are most abundant in Central and South America. Re-examination of the Central Asiatic species known as *Felis tristis* has, however, led the present writer to believe that it is an Old World representative of the ocelots. If this view be correct, it will serve to show that the ocelots (as has always been supposed to be the case) originally entered America by way of Bering Strait. It is also urged that the clouded leopard (*F. nebulosa*) and the marbled cat (*F. marmorata*) of the Indo-Malay countries are also members of the ocelot group, but of a more aberrant type.

* * *

Arboreal Ancestral Mammals.

The majority of modern marsupials, it has been stated, exhibit in the structure of their feet traces of the former opposability of the thumb and great toe to the other digits; and it has accordingly been urged that all marsupials are descended from arboreal ancestors. This doctrine is now receiving wide spread acceptation among anatomical naturalists, and in a recent issue of the *American Naturalist* (November and December, 1904, p. 811) Dr. W. D. Matthew, a well-known trans-Atlantic palæontologist, considers himself provisionally justified in so extending it as to include all mammals. That is to say, he believes that, with the exception of the duckbill and the echidna, the mammalian class as a whole can lay claim to descent from small arboreal forms. This conclusion is, of course, almost entirely based upon palæontological considerations; and these, in the author's opinion, admit of our coming to the conclusion that all modern placental and marsupial mammals are descended from a common ancestral stock, of which the members were small in bodily size. To follow Dr. Matthew in his hypothetical reconstruction of these ancestral mammals would obviously be out of place on the present occasion; and it must suffice to say that, in addition to their small size, they were characterised by the presence of five toes to each foot, of which the first was more or less completely opposable to the other four. The evidence in favour of this primitive opposability is considerable. In all the groups which are at present arboreal, the palæontological evidence goes to show that their ancestors were likewise so; while, in the case of modern terrestrial forms, the structure of the wrist and ankle joints tends to approximate to the arboreal type as we recede in time. The available evidence, so far as it goes, is therefore decidedly in favour of Dr. Matthew's contention.

The author next discusses the proposition from another standpoint—namely, the condition of the earth's surface in Cretaceous times. His theory is that in the early Cretaceous epoch the animals of the world were mostly aerial, amphibious, aquatic, or arboreal, the flora of the land being undeveloped as compared with its present state. On the other hand, toward the close of the Cretaceous epoch (when the chalk was in course of deposition), the spread of a great upland flora vastly extended the territory available for mammalian life. Accordingly, it was at this epoch that the small ancestral insectivorous mammals first forsook their arboreal habitat to try a life on the open plains, where their descendants developed on the one hand into the carnivorous and other groups in which the toes are armed with nails or claws, and on the other into the hoofed group, inclusive of such monsters as the elephant and the giraffe.

* * *

A Fossil Loris.

The lorises or slow lemurs, frequently miscalled sloths, are peculiar to the Indian and Malay countries, where they are represented by the slow lorises (*Nycticebus*) and the much smaller slender lorises (*Loris*); the latter being restricted to Southern India and Ceylon. Their nearest living allies are the pottos (*Perodicticus*), of West Africa. Recently the well-known French naturalist, Mr. G. Grandidier, has described an extinct lemur from the Tertiary of France, which he believes to be nearly related to the slow-lorises, and has accordingly named *Pronycticebus gaudryi*. If the determination be correct (and the figures illustrating the memoir seem to indicate that it is), the discovery is of considerable interest, as tending to link up the modern faunas of Southern India and West Africa (which possess many features in common) with the Tertiary fauna of Europe.

* * *

The Lion in Greece.

Some time ago Professor A. B. Meyer, the Director of the Zoological Museum at Dresden, published an article on the alleged existence of the lion in historical times in Greece. A translation of this article appears in the recently issued Annual Report of the Smithsonian Institution. As regards the mention of that animal in Homer, the author is of opinion that the writer of the Iliad was probably acquainted with the lion, but this does not prove its former existence in Greece. The accounts given by Herodotus and Aristotle merely go to show that about 500 B.C. lions existed in some part of Eastern Europe. The Greek name for the lion is very ancient, and this suggests, although by no means demonstrates, that it refers to an animal indigenous to the country. Although fossil bones of the lion have been recorded, no recent remains of that animal are known from Greece; but this cannot be regarded as a matter of any importance in connection with the question. On the whole, although the evidence is not decisive, it seems probable that lions did exist in Greece at the time of Herodotus; and it is quite possible that the representation of a lion-chase incised on a Mycenean dagger may have been taken from life. In prehistoric times the lion was spread over the greater part of Europe; and if, as is very probable, the so called *Felis atrox* be inseparable, its range also included the greater part of North America.

It may be mentioned that the journal above-mentioned also contains a translation of an article giving an account of the discovery of the mammoth carcase recently set up in the St. Petersburg Museum. In publishing translations of articles of such general interest as the above, the Smithsonian Institution is doing good service to science, for although many of us have a more or less intimate acquaintance with German, it is but few who can read Russian or Norwegian.

* * *

Fish-Lizards.

Many years ago the present writer contributed to "Knowledge" a popular account of the extinct marine reptiles known as ichthyosaurs, or fish-lizards. The same group has afforded to Professor H. F. Osborn the subject for an exquisitely illustrated article in the January number of the *Century Magazine*. These creatures, as anyone may satisfy himself by a visit to the Natural History Museum, had paddle-like limbs of a most peculiar type; but Professor Osborn is of opinion that these may be derived from a limb of the type of that of the living New Zealand tuatera, a primitive terrestrial lizard. Owing to the remarkable state of preservation of some of their fossil remains, we know not only that fish-lizards had a fin on the back, and another at the end of the tail, but likewise that they possessed a smooth skin and produced living young; the latter feature being an adaptation to their purely aquatic mode of life.

* * *

New Species of Wapiti.

In the *Proceedings* of the Biological Society of Washington of February 2 Dr. C. H. Merriam describes the wapiti deer, or elk (as it is miscalled in America), of California as a new species, under the name of *Cervus nannodes*. It differs from the typical wapiti of the Rocky Mountains by its inferior size, relatively shorter legs, and paler colour, the front of the limbs being golden tawny in place of black. Of course this animal is not a species in the sense in which that term is employed by many naturalists, but merely a local race.

* * *

The Paddles of the Fish-Lizards.

Mr. J. C. Merriam, in the *American Journal of Science* for January, shows that so early as the period of the Trias, or New Red Sandstone, the fish-lizards, or ichthyosaurs, displayed two distinct types of paddles; the one broad and the other narrow. The broad-paddled type (*Mixosaurus*) is considered to be the

one from which both the broad-paddled and narrow-paddled forms of the Lias have originated, thus upsetting the older view as to the narrow-paddled group being the primitive type.

* * *

Cobra Poison.

An important communication on the action on the human system of the poison of the Indian cobra is published in a recent issue of the *Philosophical Transactions* of the Royal Society, based on investigations undertaken at the instance of the Secretary of State for India by Surgeon-Captain Elliot. While earlier investigators ascribed death from cobra-venom in most cases to paralysis of the respiratory centres, the author concludes that the main cause is a rise of blood-pressure caused by the contraction of the minute arteries, which thus afford a barrier to the circulation.

* * *

Papers Read.

At the meeting of the Zoological Society on February 21, Mr. Lydekker contributed one paper on the giraffes of Nigeria and the Kilimanjaro district, and a second on dolphins from India. Messrs. Thomas and Schwann gave an account of a collection of South African mammals, describing a new species of shrew; and Mr. Pocock pointed out that the Somali kudu was subspecifically distinct from the typical southern form of that animal. On March 7, at the meeting of the same Society, notes were contributed on the marine fauna of the Cape Verde Islands, Mr. Regan reviewing the species of certain South American genera of fishes; and Captain Meinertzhagen described a new kind of oribi antelope from British East Africa. At the meeting of the Linnean Society on March 2, the subject of zoölogical nomenclature was discussed, and the hope expressed that tautonomies, such as *vulpes vulpes* and other comical arrangements, would be discarded.

* * *

It is generally understood that insects, like other "cold-blooded" creatures, have no temperature of their own, but put themselves in equilibrium with that of the surrounding medium, air or water. M. Acloque summarising in *Cosmos* recent investigations on this subject, suggests, however, that there are several experiments to show that the generalisation is not true in all cases, and that there are reasons for supposing that insects produce heat. A Fahrenheit thermometer was found by Inch to rise seven degrees in an ant-hill, and Swammerdam and Réaumur observed that the temperature of beehives keeps above that of the external air in winter. According to Huber, who repeated these observations, this temperature is nearly constant at 88° Fahrenheit. Réaumur added that when the bees were agitated they caused their wings to vibrate with great rapidity, and the interior heat then increased to such a point that the walls became warm, and sometimes even the wax melted. However this may be, we may say that the heat given off individually by insects is always very slight. By way of compensation, they confirm the general law according to which living creatures resist cold better as their ability to give off heat is slighter. Caterpillars do not necessarily die when turned into bits of ice; and this resistance to cold explains why we can find insects in regions very near the Pole, and why the rigours of our own winters do them so little injury. Certain species, and in particular some lepidoptera, hatch out only in winter, which explains again, perhaps, how it is that some flowers like the yellow Cape jessamine, now blooming in Surrey, can become fertilised in winter. Insects bear heat as well as cold, and Kirby and Spence have affirmed that some can survive immersion in boiling water.

SCIENCE YEAR BOOK.

Attention may be called to the announcement that appears in our advertisement pages of the Reduction in price of the Science Year Book for 1905. This should be an opportunity for all persons interested in Science to acquire, at a very small cost, this book which *Nature* says "should be found on the writing table of every astronomer and meteorologist," and "all who are interested in natural phenomena or concerned with scientific progress."

REVIEWS OF BOOKS.

Terrestrial Magnetism and Its Causes, by F. A. Black. (Published by Gall & Inglis; price, 6s. net). The complex question of the magnetism of the earth and its consequent influence on the compass needle has been treated from an entirely new basis of hypothetical speculation by Mr. F. A. Black, in this recent work. The elucidation of the natural laws which cause the magnetic needle to point approximately North and South; the daily, seasonal, and secular variation in its direction, and in its inclination or dip; the causes of magnetic storms and their connection with sun-spots and auroræ; in short, every subject connected with the earth's magnetisation and its influence on the magnetic needle is dealt with by the author in the theory promulgated by him. He adopts the assumption, based on scientific opinion, that a tenuous medium of an electrical nature permeates the space through which the earth moves in its orbit; that the sun's activity causes displacements or currents of this medium which are impelled with great velocity towards and upon the earth, thus causing the earth in its diurnal rotation to be enveloped from apex to apex by a sheet of electricity with an apparent contrary motion, so that it is magnetised by induction, and is consequently an electro-magnet. The various puzzling phenomena connected with the magnetic needle in relation to the earth's magnetism are treated in an exhaustive manner, and the deductive reasoning proved by means of diagrams. The book is unmistakably the result of deep study and research on the part of the author, and the able arguments set forth in support of his theory are undoubtedly well worthy the consideration of magnetists, physicists, and others interested in this department of science.

Astronomy for Amateurs, by Camille Flammarion, translated by Francis A. Welby (Fisher Unwin). Price 6s. 340 pp. This is one of those fascinating little books that do so much to spread scientific interest among the people. Being written by so well-known an astronomer and author, it should have an even wider interest than many other books of its kind. Much of it is almost poetic in its imaginative descriptions, and the translation has been most successfully carried out. It is, however, a pity that some of the illustrations do not follow suit. They may be poetic and imaginative—many are of young ladies in flimsy attire gazing at the hazy heavens—but they are neither artistic nor descriptive. The "Contents" includes an "Introduction" and an "Index," but neither of these desirable additions appears in the print.

Popular Star Maps, by Comte de Miremont, F.R.A.S. (G. Philip and Son; price 10s. 6d. net.) These maps, with an introduction to explain the principle employed in projecting them, short account of "Star Nomenclature," and lists of stars shown in the maps, both in alphabetical order and in order of Right Ascension, certainly form "a rapid and easy method of finding the principal stars." On the other hand, this work forms a somewhat bulky and elaborate apparatus for so simple a requirement. Ten large plates are given, in which the white stars stand out well on a dark blue ground, each with its key map. Yet only the brightest stars are depicted, with but few smaller than the 3rd magnitude. The constellations are thus distinctly portrayed for the novice in astronomy, but for those seeking more detail there is little information.

Chemistry in Daily Life, translated from the German of Dr. Lassar Cohn by M. M. Pattison Muir, M.A. (Grevel and Co.; price, 5s.). This is the third edition of a cousre of thoroughly practical lectures, which should be widely read as giving a most necessary addition to the education of the average Englishman. It would be hard to beat this little work for simplicity and clearness of language and great scope of its teachings. The latter may be made evident from a glance at the table of contents, which includes: Analysis of air, breathing, combustion, matches, candles, oils, petroleum, coal gas, incandescent gas lights, electric furnace, food of plants, manures, food of men and animals, diets, digestion, wines, explosions, fabrics, leather, dyeing, painting, inks, acids, soaps, glass, bricks, photography, X-rays, metals and alloys, and many other items. It must be acknowledged that to have some scientific knowledge on all those every-day subjects is both of great interest and undoubted utility, and a man who can pack the information contained in this book into his brain will, in our opinion, be of far

more practical use in the world than he who has devoted the same amount of time to a study of Greek. We commend the book especially to school-masters and others interested in the education of boys and young men, but none the less do we advise all those who are not well up in these subjects to dip into the book, after which their interest is sure to be aroused, and the work read from cover to cover.

Remarkable Comets, by W. T. Lynn: 12th Edition, Revised. (Sampson Low, Marston, and Co., Limited; London, 1905; p.p. 46; price 6d.). Our astronomical readers are, no doubt, acquainted with this concise summary of the more interesting facts in the history of cometary astronomy, and the present edition, the twelfth, brings the account up to date. As in former editions the author restricts himself to the appearance and reappearance of comets and their periodicities, and only refers in a very brief manner to the relationship between comets and meteor-swarms. The physical characteristics are, as usual, almost neglected, lying outside the scope of the survey. As the book is intended as a handy book of reference to comets which may be considered remarkable, its value would be very much enhanced if, in future editions, a brief bibliography were added at the end. This would most certainly assist those who wish to learn more about comets than that which is contained in these pages, and would be very efficiently done if compiled by the author of this excellent little treatise.

A Revised System of School Teaching, by Richard Chichester (H. J. Glaisher; 1s. net). This is a pamphlet describing a new system which might be adopted in schools. The idea is founded upon the fact that "so often a boy, on reaching a high class, being asked a comparatively simple question, answers that he never learnt it" (presumably meaning the answer). When such an occurrence is frequent, reform is certainly needed, but we should have thought it exposed a fault in the detail of teaching rather than in the principle. An idea well worthy of consideration is here suggested, which is that, instead of boys being placed in one "form" or "class" for all subjects, "Divisions" should be formed for instruction in each particular subject. All schoolmasters should read this pamphlet, which may suggest to them some useful wrinkles.

A List of English Clubs for 1905, by E. C. Austen Leigh, M.A. (Spottiswoode and Co.), will often be found of great use, containing, as it does not only details of all the London and Provincial Clubs, but also those of English Clubs all over the world, with membership, subscriptions, &c.

China Decoration and Repair, by Rev. F. C. Lambert (Dawbarn and Ward; 6d.), is a useful little guide, but contains some very inartistic designs.

The Children's Book of Moral Lessons, by F. J. Gould (Watts and Co.; price 6d.). The moral instruction of children is too frequently sadly neglected, and Biblical History supposed to suffice in this respect. The little work before us is an attempt to impart such moral instruction under the guise of short anecdotes.

Williams and Norgate's **International Book Circular** is practically a bibliographical *résumé* of the world's best literary productions in all branches of science and learning published during the last few weeks, and as such will be found of great value to students of science.

How to Build a Lathe. By A. W. Burford, A.M.I.C.E. (Dawbarn and Ward), price 6d. net. (cloth 1s.), forms No. 9 of the series of "Utility" Practical Handbooks, some of which we have already noticed. To build up a lathe from the raw materials is instructive as well as being a cheap means of obtaining a valuable possession. The instructions herein given are very practical, and a number of diagrams add to the explanations in the text.

Lessons in Experimental and Practical Geometry. By H. S. Hall, M.A., and F. H. Stevens, M.A. (Macmillan), price 1s. 6d. It is perhaps quite sound, though not altogether in keeping with practice, "to give to a young pupil clear mental pictures" of geometrical principles. To graphically explain what is meant by lines, planes, angles, and all the other constituents, the consideration of which go to make up geometry, is the object of this little book. The idea is well carried out, and we can confidently recommend this brochure to teachers of elementary Geometry.

An Improvement in the Wimshurst Machine.

By Charles E. Benham.

Many years ago the late Mr. Wimshurst established the fact that the electric influence machine which he invented will work without the tinfoil sectors if large brushes are used and if the varnish on the plain plates is new. Under such conditions the machine is not only self-exciting, but the sparks are even longer than when sectors of tinfoil are present. The reason for the increase in spark-length is no doubt the greater immunity from leakage. On the same, or, rather, the converse principle, the increase of the number of sectors diminishes the length of spark on a Wimshurst by increasing the leakage. It is obviously inconvenient to be constantly renewing the varnish on the glass plates, so that the sectorless Wimshurst, though interesting for exhibition as a class-room experiment, is not adapted for practical work. By a simple expedient, however, the efficiency of the machine may be increased and the required immunity from leakage reduced to a minimum without altogether doing away with the sectors and rendering the self-excitement dependent on the condition of the varnish. The way to do this is to make every alternate sector of a semi-conducting substance instead of tinfoil. Thin white card seems to answer best. The cardboard sectors may be larger than the intermediate tinfoil sectors. The only reason why cardboard alone cannot be used is that self-excitement is not assured, especially in very dry weather. Very narrow sectors of tinfoil between the card sectors will ensure the self-excitement, and as soon as the potential increases, the semi-conducting card acts fully as efficiently as metal, with the advantage that there is considerably less leakage and a longer spark. The arrangement is equally efficient in all sorts of atmospheric conditions, a small vulcanite-disc machine of eight inches diameter responding promptly after being left for some hours near an open window on a damp, foggy day, and giving at once strong sparks of $2\frac{1}{2}$ inches length. The cardboard sectors on each plate of this machine number 16, and a narrow tinfoil strip is placed between each two. The cardboard should be attached firmly with strong glue, the corners of the sectors being carefully rounded with scissors before they are fixed to the plate. Working the machine at full strain, with the dischargers wide apart, in the dark, its immunity from loss by leakage is at once apparent.

Acetylene as an Explosive.

M. Guedras has been experimenting in Paris with acetylene as an explosive. The carbide is granulated and charged in a special form of cartridge, consisting of an iron-cylinder, in the bottom of which the carbide is placed. Above this is stretched a membrane, and the top is filled with water. A rod is so fixed in the cartridge, that when its end is struck it pierces a hole in the membrane, which lets the water on to the carbide, and acetylene gas is formed. The charge is fired by an electric fuse inside the cartridge.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Toning with ferricyanides.—It is very desirable, at least for the serious worker, to know exactly what chemical changes take place during photographic operations, so that the operations may be intelligently controlled and the character of the product understood. It was therefore with a pleasurable expectancy that I read a few weeks ago a communication from Messrs. A. and L. Lumière and A. Seyewetz on the composition of the resulting image when a silver image is toned by means of a solution of potassium ferricyanide mixed with either a ferric, copper, or uranium salt. But it is with a feeling of disappointment that I refer to the paper, for the authors appear to have done little more than begin to find the difficulties of the investigation. They show that when finely divided metallic silver is acted on by a solution of potassium ferricyanide, the silver does not simply attach itself to the ferricyanide to form a double ferrocyanide, thus—

$$K_3FeCy_6 + Ag = K_3AgFeCy_6,$$

but that two salts are formed,

$$4\ K_3FeCy_6 + 4\ Ag = Ag_4FeCy_6 + 3\ K_4FeCy_6,$$

and that the potassium ferrocyanide may be washed away, leaving the silver ferrocyanide. But when the metallic silver is suspended in a gelatine film, as it is in an ordinary developed image, they get a quite different result by the action of potassium ferricyanide upon it. The product then contains about twice as much iron as it ought in proportion to the silver, after allowing for a very small quantity of potassium which appears to be due to incomplete washing. The presence of this extraordinary proportion of iron (or deficiency of silver) remains a mystery.

When the ferricyanide of potassium is mixed with ferric citrate as in iron toning or blue toning, the ferric ferricyanide produced might be expected to combine with silver directly forming silver ferric ferrocyanide ($AgFe^{III}FeCy_6$), or if the potassium ferricyanide first forms silver ferrocyanide as shown above and this reacts with the ferric citrate, the silver might be entirely replaced by iron and Prussian blue result ($Fe_4(FeCy_6)_3$). But the analysis of the product shows about five times as much silver in proportion to the iron as represented by the first formula. Probably a large amount of the silver in the original image is unattacked.

When a copper toning solution is used we might similarly expect to get either a double ferrocyanide of copper and silver ($Cu_3Ag(FeCy_6)_2$) or merely ferrocyanide of copper (Cu_2FeCy_6), a chocolate coloured substance to which the colour produced on toning is generally supposed to be due. A considerable quantity of silver was found but the proportion of iron was nearly double that required according to either formula. The approximately double proportion of iron in this case, and also when the simple potassium ferricyanide acts on finely divided silver in gelatine, seem to point to a reaction that would repay investigation.

Variations in Platinum Printing.—The platinum process has many advantages, the chief of which are the permanency and the beauty of the results that it furnishes. But to let well alone is not the nature of photographers, and it is too often the case that those who try to improve processes have only an empirical knowledge of them, and know nothing about the suggestions that they make and the modifications that they propose, except that the prints they get are different from ordinary prints. The methods initiated by such workers must always be unsafe until they have been properly investigated.

The image in a platinum print consists of metallic platinum, and therefore it can only be affected by adding something to it. Many methods of toning, and so on, have been suggested, but they all, except perhaps one in which gold is used, consist in depositing upon the image substances that cannot be compared with platinum for permanency. No reliance can be placed upon such compound images, and it is not right to call them platinum prints, for the great advantage of platinum, its unchangeableness, has been compromised. By adding a small proportion of certain salts, especially salts of mercury, to the mixture with which the paper is coated, or, less advantageously, to the developing solution, the colour of the deposited platinum may be modified to a warmer tint. This applies particularly to hot development. Here also the image consists, I believe, of pure platinum, for it behaves as if it were so, and neither metallic mercury nor mercurous chloride can exist in contact with the platinum salt without immediately depositing metallic platinum. The paper supplied commercially for sepia prints gives images that seem to be as unchangeable as the ordinary black platinum image. But suggestions have been made and formulæ given for adding comparatively large quantities of extraneous salts to the coating solution or the developing solution, and there is practically no doubt that in many of these the limit of safety has been passed and the image is not platinum and not permanent. I believe that it may be truly stated that if the image is affected by any reagent that the paper it rests on will withstand, it is not a genuine platinum print. Such reagents as hydrochloric acid, chlorine water, and potassium cyanide may be used.

Received.—The Thornton-Pickard Company send their new catalogue, in which the important novelties described are the "Royal" shutter, similar to their "Standard" "time and instantaneous" shutter, but with the mechanism inside the case, and so protected from dust and other damage; and a bellows-form of ball compressor, which is better than the simple ball in that it delivers always the same volume of air, and thus contributes to the uniform working of the time exposure valve. A prize competition is announced.

Mr. William Hume, of 1, Lothian Street, Edinburgh, publishes a list of his enlarging apparatus in their many varieties, and with almost innumerable accessories, including also valuable suggestions as to the selection and using of them; indeed, it is a guide book as well as a list. The application of modern illuminants such as acetylene, arc lamps, Nernst lamps, and incandescent gas, as well as oil lamps and the limelight, are fully dealt with. Mr. Hume was the first to use the word "cantilever" in this connection as a "selling name," and has specialised in enlarging apparatus since the year 1888.

Messrs. Taylor, Taylor, and Hobson, of Leicester, have just published their new catalogue of lenses, &c., which includes other items of information likely to be useful to photographers, and will be sent to any applicant who mentions the name of this journal. They have introduced two new series of Cooke lenses. Series II. are portrait lenses with a maximum aperture of f/4·5, and will give sharp or softened definition at will. Series IV. have an aperture of f/5·6, and are specially suitable for high-speed shutter work in general.

Messrs. Kodak are again inviting competition for several valuable money prizes for work done with Kodak apparatus and materials. About one half are reserved for those who have not yet won a prize in such competitions. Entries will be received up to the end of September, and full particulars may be obtained from the Company.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Fibrous Constituents of Paper.

(*Continued from Page* 68.)

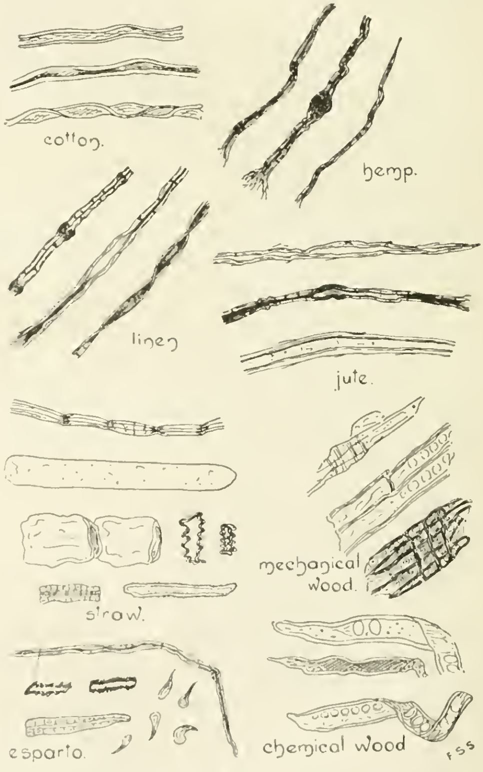
CHLOR-ZINC iodine gives a characteristic bluish violet reaction with cellulose, becoming reddish-brown to claret-coloured for rag and similar fibres, and light to dark yellow for lignified fibres. We have thus a ready means of distinguishing the fibres by their colour reactions alone, which we may summarise as follows:—Linen, cotton, hemp, reddish-brown to claret; esparto, straw, and chemical wood-pulp, bluish-violet; mechanical wood-pulp and jute, yellow. Jute may be more blue than yellow, whilst manilla hemp—an entirely different fibre to hemp itself—will be blue rather than red.

With polarized light the fibres also behave differently. The nicols being crossed so that the field is dark, it will be seen that linen and hemp give a brilliant play of colours, especially if the microscope has a stage which can be rotated; jute gives these colours in a rather less degree, cotton or wool still less; whilst esparto, straw, and wood-pulp are colourless. It will be observed also that the various structural details of the fibres are brought out very clearly by this method, and this is of service in making the final examination, as it will be observed that neither the chlor-zinc iodide differentiation nor that with polarized light are necessarily quite determinative.

The examination of the structural differences of the various fibres is, however, the most difficult of all, and requires more experience than is apparent at first sight, not a little of the difficulty being due to the rough treatment the fibres have undergone as already mentioned. A study of the accompanying illustrations will assist the reader in following the description.

Cotton shows flat, ribbon-like fibres with a large lumen about two-thirds of its total diameter, so that the cylinder, being weak, has collapsed in places and thus given rise to a sort of spiral twist which forms the most characteristic distinction of this fibre. It should be noted, however, that the boiling in caustic soda largely counteracts this twist, as does the breaking up in process of manufacture, so that the absence of the twisted appearance does not necessarily decide the question. The fibres also show fine, lattice-like markings, and it will be observed that they are free from thickening or knots. The ends are often laminated. Taken altogether, the wide lumen, the spiral twist, the markings, and the freedom from knots form characteristic features which make cotton one of the easiest fibres to distinguish.

Linen and hemp are so much alike that it is almost impossible to distinguish them, but they are not often found in the same classes of paper, or where identification and separation from each other is necessary. The fibres are smaller than those of cotton—about half as thick—and they have a very small lumen, so small that it often appears little more than a narrow central line. In places, however, the pressure which the fibre has undergone during pulping may have flattened out the central canal so that it bears a strong resemblance to a jute fibre or even to cotton. The frequent thickening into knots is very characteristic, but otherwise the fibre is fairly uniform in thickness, and cylindrical. There are also numerous dark cross lines which come out well under polarized light. The ends are often drawn out into fine fibrillæ.



Jute fibres have a peculiarly uneven appearance. The wall is thick and thin in places, and the central canal varies proportionately in width from a thin line to a canal as broad as that of cotton, and all these changes may be observed without moving the slide. They also show cross-striations and knots, but less frequently than linen or hemp. Jute is a very intractable fibre, and accordingly the fibres will be often observed sticking together in parallel bundles. It is most difficult to bleach, and its use is, therefore, almost entirely confined to coarse papers.

Straw fibres are smooth and even, cylindrical, uniform in diameter, and with a central canal of varying size, but at intervals knots appear. Striations are

likewise seen. A certain number of flat, oblong cells from the parenchyma are always found in papers made from straw, and ring-like portions of spiral and annular vessels may also be found, but the most characteristic features are the numbers of finely-serrated epidermal cells, which are thick-walled with jagged edges. They must, however, not be confused with the somewhat similar cells in esparto.

(*To be Concluded.*)

Royal Microscopical Society.

February 15, at 20, Hanover Square, the President, Dr. Dukinfield H. Scott, F.R.S., in the chair, the Secretary read Mr. Finlayson's description of the Ashe-Finlayson Comparascope. This is an apparatus designed to show two images side by side in the microscope for comparison, and consists of the attachment to any ordinary microscope of a second objective, stage, and illuminating apparatus, placed on one side at right angles to the optical axis of the microscope. On the nosepiece of the latter is screwed a short tube with a circular aperture at one side, and containing a reflector extending half-way across, placed at an angle of 45° to the axis of the tube. The subsidiary apparatus is applied at this aperture, the reflector thus transmitting the image of the second slide to the eye-piece. The reflector utilises half the diameter of the tube, the other half serving for the passage of light from the primary objective direct to the eyepiece. A diaphragm or division plate extends up the tube from the reflector almost to the eyepiece to prevent overlapping of the images, which appear together as two semicircles, equally distinct. Mr. C. Beck exhibited a new optical bench for microscopic illumination, photomicrography, micro and lantern projection, and a large micro-photographic and enlarging camera, both bench and camera being mounted on special tables. Mr. J. E. Stead, F.R.S., delivered the first part of a lecture on "Practical Micro-Metallurgy." He alluded to Dr. Sorby's pioneer work on this subject some forty years ago. Dr. Sorby's method was very simple, a small piece of metal being ground down to a flat surface, and finally polished on various grades of emery-paper, finishing with rouge parchment. This method was still adopted, but by means of special machinery the process was reduced from two or three hours to five minutes. Mr. Stead described this machinery, and explained the various processes of cutting, grinding, and polishing, also the different methods of preparing the polished surface so as to render the structure visible, their mounting, and also suitable illumination. The lecture was illustrated both by lantern slides and by actual specimens, the beautiful colours due to heating being shown in a quite novel way.

The Quekett Microscopical Club.

The 420th ordinary meeting, which was also the annual meeting, was held on February 17 at 20, Hanover Square, the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. The annual report and balance sheet were read, and gave evidence of a larger membership and improved financial position as compared with the previous year, the number of new members elected during the year being 50, whilst the total membership amounted to 382. Dr. E. J. Spitta was re-elected President, and all the other officers were also re-elected, except that Mr. J. J. Vezey, F.R.M.S., was elected as a Vice-President instead of Mr. George Massee, F.L.S., who retires. Mr. A. D. Michael, F.L.S., delivered the annual address, dealing with "Improvements Effected in Modern Objectives," with special reference to the various corrections necessary for both objectives and eyepieces, the use of Jena glasses, and their results, as evidenced in the apochromatic lenses and the improvement in achromatic lenses, which justify their description under a new name as semi-apochromatic.

Notes and Queries.

Bausch and Lomb's Portable Microscope.

With reference to my notice last month of this microscope, and my remark that in the instrument sent me the condenser did not quite come into focus, I am informed that this is purposely put out of focus to prevent the upper and auxiliary diaphragm being damaged by accidentally coming in contact with the condenser top, and that by means of a screw thread in the condenser mount the optical part can, if required, be brought level with the stage. But as it is a primary requirement that a condenser should readily focus, it seems to me that this is an undeserved concession to careless workers, the more so as the upper diaphragm and the condenser are not generally used together. A preferable way, if the upper diaphragm is retained, would be to alter the construction of the condenser so as to give it a slightly longer focus. In the meantime, it is only fair to Messrs. Bausch and Lomb to add this explanation.

C. A. Winckworth (*Brighton*).—I think that from your description there can be little doubt that what you have observed was merely an amœba undergoing division. Under any circumstances, they could not be bacteria.

Dr. W. J. Branch (*St. Kitts*).—Your question touches on a matter which has exercised many minds, but only through a misapprehension of the true principles involved. Assuming that you could have a film that showed no grain under the highest magnification, you could, of course, easily enough magnify an image photographically impressed upon such a film, and repeat the process as often as you wished, but in each stage you would be merely magnifying what existed on the original film. Now what you had upon the first film depends on the aperture of the lens through which the photograph was taken—in other words, the aperture of the lens governs its resolution, and you would get no more *detail* by subsequent magnification. So that the mere fact that you enlarged a fine, but perfectly distinct, line into a broad and coarse one would be useless. The experiments you allude to tend to make fine detail resolved by the objective more evident to the eye, but that does not affect the issue.

Miss F. Elliot (*Staines*).—I much regret that pressure on my space prevented my answering your query last month. *Hircinia variabilis* is a horny sponge, very variable in shape, as its name implies. The simplest forms are incrusting, horizontally expanded, and more or less cake-shaped. It often grows more vertically than horizontally, and attains an irregular globose form. Sometimes, owing to uneven rapidity of growth, rugose, tubercular, or even lobose forms are produced, but in any case the sponge appears as a crust from the upper surface of which these processes arise. The crust is sometimes much curved, raised in the centre, and attached at the margins only. The surface is covered with conuli, the oscula are large and conspicuous, and the colour light to dark brown in the living state. The sponge consists of slightly fascicular main fibres, joined by connecting fibres which form a mesh or net-work. There are several varieties, several of which are found in the Adriatic, and it is found also in the Pacific Islands, India, Australia, Jamaica, Florida, &c. For the life history of sponges I am afraid I must refer you to any good book on Zoology, and unless I know more exactly what you wish specially to examine I can scarcely advise you as to methods. You might begin with a little dissecting, and then cut sections by hand. "Knowledge" is the only English journal which deals systematically with Microscopy, and I regret with you that the space at my disposal is not larger, but I will gladly give you any assistance in my power.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for April.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 5.38, and sets at 6.31; on the 30th he rises at 4.37, and sets at 7.19. The equation of time is negligible on the 16th. Sunspots and faculæ are usually conspicuous on the solar disc, marking a return to maximum activity, whilst prominences also continue to be numerous.

For plotting the positions of spots, &c., the following table gives the necessary data:—

Date.	Axis inclined from N point.	Equator N. of Centre of disc.
April 1 ..	26° 23′ W.	6° 28′
,, 11 ..	26° 23′ W.	5° 47′
,, 21 ..	25 45′ W.	4° 58′
May 1 ..	24 20 W.	4° 0′

The Moon:—

Date.	Phases.	H. M.
April 4 ..	● New Moon	11 23 p.m
,, 12 ..	☽ First Quarter	9 41 p.m.
,, 19 ..	○ Full Moon	1 38 p.m.
,, 26 ..	☾ Last Quarter	11 14 a.m.
April 4 ..	Apogee	9 0 a.m.
,, 15 ..	Perigee	10 6 p.m.

Occultations.—The only bright star occulted during convenient hours is η Virginis (mag. 4·0) at 8.18 p.m. on the 17th.

The Planets.—Mercury is an evening star in Aries, being at the most favourable eastern elongation of the year on the 4th, when he sets at 8.30 p.m. He should be looked for immediately after sunset, nearly due west and rather low down. On the evening of the 6th he is 7½° N. of the thin crescent moon. The planet is in inferior conjunction with the Sun on the 23rd.

Venus continues to be a brilliant object in the evening sky during the earlier part of the month, and sets about 10.10 p.m. on the 1st. The planet sets earlier each day, and is in conjunction with the Sun on the 27th. As seen in the telescope, the planet exhibits a crescent which is thinning out but increasing in apparent diameter; on the 15th, ·05 of the disc is illuminated, the diameter being 55″.

Mars is not in a favourable position for observation, being situated low down in Libra. About the middle of the month he rises at 9.30 p.m. and comes to the meridian at 1.50 a.m.

Jupiter is practically out of range for observation, setting at 8.30 p.m. on the 7th; from this date to June 1st the satellites are invisible, as the planet appears too near the Sun. The moon is near Jupiter on the evening of the 6th.

Saturn is a morning star in Aquarius, rising about 3.45 a.m. near the middle of the month.

Uranus does not rise until after midnight; he is situated low down in Sagittarius.

Neptune is on the meridian before sunset, but is observable in the west until midnight, as he sets about 1 a.m. on the 15th. The planet is near μ Geminorum, and can most readily be found by reference to that star.

	Right Ascension.	Declination.
Neptune (April 15).	$6^h\ 24^m\ 16^s$	N. 22° 21′ 51″
μ Geminorum . .	$6^h\ 17^m\ 13^s$	N. 22° 33′ 38″

Meteor Showers:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17-May 1	16 0	+ 47	τ Herculids	Small; short.
,, 20-21	17 24	+ 36	π Herculids	Swift; bl. white.
,, 20-22	18 4	+ 33	Lyrid Shower	Swift.
,, 30	19 24	+ 59°	o Draconis	Rather slow.

Minima of Algol may be observed on the 9th at 11.5 p.m., and on the 12th at 7.54 p.m.

Telescopic Objects:—

Double Stars.—γ Virginis, XII.^{h} 37^m, S. 0° 54′, mags. 3, 3; separation 5″·9. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of a power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^m, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ε Boötis, XIV.^{h} 41^m, N. 27° 30′, mags. 3, 6½; separation 2″·7. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.^{h} 47^m, N. 19° 31′, mags. 5, 7; separation, 2″·5. Binary; one component being orange, the other purple.

Clusters.—M 3 *(Canes Venatici)*, XIII.^{h} 38^m, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.

Royal Institution.—The following are the Lecture Arrangements at the Royal Institution, before Easter:—A Christmas Course of Lectures (experimentally illustrated and adapted to a juvenile auditory) on Ancient and Modern Methods of Measuring Time, by Mr. Henry Cunynghame; Professor L. C. Miall, Fullerian Professor of Physiology, R.I., Six Lectures on Adaptation and History in the Structure and Life of Animals; Professor Karl Pearson, Three Lectures on Some Recent Biometric Studies; Professor W. E. Dalby, Two Lectures on Engineering; Mr. A. H. Savage Landor, Two Lectures on Exploration in the Philippines; Mr. Churton Collins, Two Lectures on (1) The Religion of Shakespeare, (2) The Philosophy and Significance of "The Tempest"; Professor W. Schlich, Two Lectures on Forestry in the British Empire; Mr. J. J. H. Teall, Two Lectures on Recent Work of the Geological Survey; Professor H. H. Turner, Three Lectures on Recent Astronomical Progress; Professor R. Meldola, Two Lectures on Synthetic Chemistry (Experimental); Sir Alexander Mackenzie, Three Lectures on the Bohemian School of Music (with Musical Illustrations); Mr. D. G. Hogarth, Two Lectures on Archæology; Professor J. J. Thomson, Three Lectures on Electrical Properties of Radio-active Substances; and the Rt. Hon. Lord Rayleigh, Three Lectures on Some Controverted Questions of Optics. The Friday Evening Meetings will begin on January 20, when a Discourse will be delivered by Professor Sir James Dewar on New Low Temperature Phenomena; succeeding Discourses will probably be given by Dr. E. A. Wilson, Mr. Cecil Smith, Mr. J. W. Gordon, Professor H. Marshall Ward, Chevalier G. Marconi, Professor J. J. Thomson, Sir Squire Bancroft, Professor G. H. Bryan, Professor J. Wright, Professor T. C. Allbutt, the Rt. Hon. Lord Rayleigh, and other gentlemen.

Knowledge & Scientific News

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CONTENTS.—See Page VII.

Modern Cosmogonies.

XIII.—Life as the Outcome.*

By MISS AGNES M. CLERKE, *Hon. Member R.A.S.*

THE making of world's, we are assured, was not purposeless; and its most obvious purpose to our minds is the preparation of suitable abodes for organic life. No other seems of comparable importance; no other, indeed, comes within the full grasp of our apprehensive intelligence. Its limitations, however, must not be forgotten. The human standpoint is not the only one from which the sum of things may be surveyed; and although we be unable to quit it, we can still admit that the view obtainable from it is probably not all-embracing. We only, then, know with certainty that the end which appears to us supreme has, in one case, been successfully attained; how far it was sought to be compassed elsewhere must always remain a matter of speculation.

On our own globe, the presence of life is none the less mysterious for being profuse and familiar. We can trace the strange history of its slow unfolding; but the secret of its initiation baffles our utmost scrutiny. The cooled rind of a once molten globe serves as the stage for the drama; beneath it, primeval heat still reigns. Temperature rises steadily with descent into the interior of the earth; at a depth of about two miles, it must reach the boiling-point of water at the sea-level. This temperature, which is absolutely prohibitive of vitality, was formerly, beyond question, that of the surface. At some long-past epoch, accordingly, our future oceans hung suspended as a prodigious envelope of vapour above a hot crust of slag and lava; our teeming planet lay barren; it harboured no promise, no potency, no visible possibility of life.

So it should have remained had the law of continuity been rigidly enforced; but there came a time for a new beginning, and a new beginning was made. A momentous alteration took place; inert nature was quickened; what had been sterile became all at once fruitful; an immeasurable gulf was bridged, and movement was started along an endless line of advance. That the advance was set on foot and directed by an intelligent Will is the only inference derivable from a rational survey of the known facts.

Life can be studied in its manifestations, not in itself. Attempts to define it have served only to show our inability to "lift the painted veil." We can, however, see that its presence is attended by characteristic effects, brought about in harmony with the laws or inorganic nature, although not in blind submission to them. Their operation is somehow restrained, and appears to be subtly though securely guided towards determinate ends prescribed by the vital needs of each animal or plant. This modifying principle unmistakably regulates the economy of every living organism; the cessation of its activity means death.

Science has made no progress towards solving the enigma of vitality. Its evasiveness becomes, on the contrary, more apparent as enquiry is rendered more exact. Under a laxer discipline of thought the contrast between life and death seemed less glaring. It was easily taken for granted that creeping things were engendered by corruption, aid being invoked if required from the *virtus coelestis* of the eighth sphere. Thus, the birth of mice from damp earth was, in the ninth century, held to be signified by the word *mus* (= hu-mus);* and Van Helmont, at the height of the revival of learning, published without misgiving a recipe for the creation of the same animals.† Yet there was already better knowledge to be had for the asking; and Francesco Redi, in 1668, crystallised Harvey's opinion in the celebrated maxim, "*Omne vivum ex vivo.*" Its truth is incontrovertible. Challenged and tested again and again, it has as often been vindicated, and may now be said to stand outside the range of debate. "That life is an antecedent to life," Lord Kelvin declared in 1871, "seems to me as sure a teaching of science as the law of gravitation."‡

But the succession is not easy to start within the terms of a strictly uniformitarian convention. The expedient is tempting, if scarcely satisfactory, of demanding from the past what we dare not claim from the present. Two and a half millenniums ago, it was already in vogue. Herodotus dismisses a genealogical embarrassment with the remark; γένοιτο δ'άν πᾶν έν τῶ μακρῶ χρόνω, which may be freely translated, "In the long run of time, anything may happen." Conditions, we are apt to think, may have been more elastic long ago. The proven impossibility of to-day becomes vaguely thinkable seen through the mist of uncounted yesterdays. "If it were given to me," Professor Huxley said,§ "to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions which it can no more see

* *Continued from February.*

* Hewitt, *Problems of the Age*, p. 105.

† Pasteur, *Annales de Chimie et de Physique*, t. XLIV., p. 6, 1862

‡ *Popular Lectures and Addresses*, Vol. II., p. 198.

§ *Report Brit. Ass.*, 1870, p. 84.

again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from non living matter." To these first vital compounds, he attributed a fungoid nature and mode of growth: and the choice deprived his speculation of any plausibility that might otherwise have belonged to it. Fungi are not self-supporting; they cannot supply themselves with nourishment from the raw materials of the mineral world; they depend upon the hospitality of differently organised beings. They were then certainly not among "the first mercies of nature." Mr. Herbert Spencer, too, was inclined to regard spontaneous generation as a superannuated process. The leap from the non-vital to the vital, now admittedly impracticable, might have been taken, it seemed to him, when "the heat of the earth's surface was falling through those ranges of temperature at which the higher organic compounds are unstable." But the "reason why" is to seek. A sterilised solution is precisely one which has cooled from a high thermal grade: a baked brick is similarly circumstanced. Why should the appearance of life in primeval times have been favoured by a state of things fatal to it here and now?

The essence of the biological crux resides in "protoplasm." The word was coined by Von Mohl in 1846 with the object of emphasising the importance of the substance signified, which indeed forms the bulk of every organism, animal and vegetable, man, mushroom, and amœba. Huxley rightly termed it "the physical basis of life," adding, however, the infelicitous conjecture that its production might have been one of the lucky hits of nature. It would have been a hit of incalculable moment, but of incalculable improbability. "Odds beyond arithmetic" were against that particular throw coming out of the Lucretian dice-box. The "primal slime" (to use Oken's phrase) is composed of oxygen, nitrogen, hydrogen, and carbon, with minute percentages of phosphates and other salts. But these constituents are put together in a highly artificial manner. Eight or nine hundred elementary atoms, in fact, go to the making of one molecule of protoplasm, forming a structure of extreme complexity, most delicately balanced, and eminently unstable. It results, accordingly, from the employment of specially directed forces, and stores, for the benefit of the producing organism, the energy expended in its construction. Left to itself, it promptly goes to pieces, and yields back its component particles to their native inorganic sphere. The laws there ruling are in truth adverse to the existence of protoplasm; abandoned to their unmitigated action, it perishes. We should then as reasonably suppose that in the geological past, rivers flowed uphill, as that inorganic nature stumbled blindly upon this wonderful postulate and product of life.

Professor Huxley affirmed life to be "a property of protoplasm," the inevitable outcome of "the nature and disposition of its molecules."* And he sought to cover the absurdity of the dictum by claiming as analogous a case wholly disparate. Water, he argued, has qualities totally unlike those of oxygen or hydrogen: and protoplasm may similarly, by mere intricacy of arrangement, and the evoking of latent affinities, become endowed with the transcendant powers connected with animated existence. "What better philosophical status, then," he exclaimed, "has *vitality* than *aquosity*?" "True," he added, "protoplasm can only be generated by protoplasm, in a manner that evades our intelligence; but does any body quite comprehend the *modus operandi* of an electric spark which traverses a mixture of oxygen and hydrogen?" The illustration, however, is inapt. The electric spark fulfils no constructive function. It simply agitates the molecules so as to bring their native affinities into play. It acts like a mechanical blow on dynamite. Further, water is a stable compound, because its formation is attended by loss of energy, and the descent to a lower plane gives permanence to its occupation. But protoplasm is, in this respect, the antitype of water. It needs force for its composition; water needs force for its decomposition. Protoplasm needs force plus a suitable apparatus; it can be turned out only by an artfully adapted machine with a head of steam on. It is thus continually manufactured by plants under the stimulus of light. They supply the apparatus, sunbeams the energy. If the supply is cut off, the machinery comes to a halt; protoplasm ceases to be generated; the plant dies of inanition.

* *Collected Essays*, Vol. I., p. 153.

Many German biologists find themselves compelled by the impossibility of explaining vital activities in terms of chemistry or physics, to associate protoplasm with some kind of psychical activity.* Individuality, at any rate, implies an ultra-material principle; and it asserts itself at the very base of the animal creation. An amœba is the simplest of living beings. Formerly called the "Proteus animalcule," it is "everything in turn, and nothing long." It can be round or radiated, spherical or lenticular, as momentary convenience prescribes. Organs it has none; its limbs are conspicuous by absence; it is "sans everything" that belongs to the ordinary outfit of an animated creature. Yet such-like nucleated globules of protoplasm have flourished exuberantly during countless ages. Adaptability ensured survival. An amœba is at home in almost any environment. What it has not ready-made, it can supply at a moment's notice. Out of any part of its substance it can improvise feelers and tentacles for the capture of its prey, as well as a stomach for its digestion; and thus effectively goes through the full round of animal economy. Some varieties, too, are noted builders. These Foraminifera have the faculty of secreting carbonate of lime from sea-water; and with it they construct fairy dwellings, perforated in all directions to allow of the protrusion of exploratory filaments. Fossil-chambered shells of this type are extraordinarily abundant. Their dense conglomeration in the chalk elicited Buffon's exclamation that "the very dust had been alive!"† The *calcaire grossier* of which Paris is built mainly consists of them; and to this day, in oceanic depths, the materials of future capitals are in course of preparation by the monumental industry of these unpretending organisms.

Such as they are, they maintain an incomparable status. Incomparable, for instance, as regards the water in which they float. An amœba incarnates a purpose; it embodies a spark of individual existence, unconsciously swaying the powers of inorganic nature towards the ends of its own well-being. The subordination is most real, though profoundly mysterious. In the organic and the inorganic worlds, the same laws hold good; the same ultimate atoms exert their preferences in each; in neither is an uncaused effect possible. A bullet can no more be fired from a gun that has no charge than a man can lift a finger without a corresponding outlay of food-products. Accordingly, while plants store and animals expend energy, plants and animals are equally incompetent for

* Neumeister, *Betrachtungen uber das Wesen der Lebenserscheinungen*, 1903.

† Owen, *Palæontology*, pp. 11, 14

its origination. What they can do is to appropriate and specifically apply it; and herein resides the essence of life. "It would seem," Sir George Stokes wrote in 1893,* "to be something of the nature of a directing power, not counteracting the action of the physical forces, but guiding them into a determined channel." What the power is in itself it would be futile to seek to define. We are only sure of its being extra-physical. Matter cannot evolve a principle which disposes of it as its master. Evolution means only the unfolding into self-evidence of something already obscurely present. The "latent process" (to use a Baconian term) of the hatching of an egg is typical and instructive. Yet it is not the less recondite for being familiar. A concourse of suns, indeed, fails to impress us with the unutterable wonder of the "flower in the crannied wall" apostrophised by the last great poet of the nineteenth century.

The two wide kingdoms of life lack a "scientific frontier." The boundary-line is ill-marked and irregular. So much so that a few naturalists have set up a neutral zone, or no man's land, inhabited by creatures of mixed or uncertain nature, by plant-animals, or zoophytes in the literal sense of the word. But the expedient avails to shelter ignorance rather than to advance knowledge. For it seems probable that there is no organism so imperfectly characterised as to be genuinely incapable of giving a categorical answer to the question, "Under which king, Bezonian?" Fungi might, perhaps, on a superficial view be taken for hybrids. They share the nature of animals so far as to be unable to elaborate their own food, while appearing in other respects to be authentic vegetables. They are, in fact, parasites and scavengers. Not the smallest reason exists for supposing them to constitute a genetic link between the two chief hierarchies. These are, in all likelihood, fundamentally distinct. Only by a gratuitous hypothesis can they be credited with a common ancestor. Each seeks a different kind of perfection; their ideals, so to speak, follow divergent tracks. That the tracks were marked out from the beginning, may be safely affirmed; and this implies radical separation. Plants came first, since animals pre-suppose and imperatively require them; the antecedence having quite possibly been by a vast interval of time. On this point, geological evidence, though inconclusive, is suggestive. The Laurentian beds, which are among the very earliest stratified formations, contain no recognisable fossils. They were once supposed to enshrine the remains of a lowly organism dubbed *Eozöon Canadense;* but the markings that simulated animal forms are now known to be of mineral origin. Laurentian graphite, on the other hand, occurs plentifully; and graphite may be described as coal at a more advanced stage of mineralisation. Such deposits, we are led to believe, consist of altered vegetable substances; and it seems to follow that these hoary rocks are the burying ground of a profuse succession of virgin-forests. That they flourished beneath the sea—were in fact composed of algæ—was the opinion of Professor Prestwich; † and it is not easily gainsaid.

Primitive animal life was unquestionably marine, and the Huronian strata, which overlay the Laurentian, afford traces of it in a few sponge-spicules, the cast of an annelid, and such-like scanty leavings. Higher up, the Cambrian series swarms with oceanic invertebrates; fishes, the first type of vertebrates, came upon the scene in Silurian times; and so, by a various and surprising progression, life advanced through the ages, until the ascending sequence culminated with a being cast in a diviner mould, who walks the earth, even now, with face uplifted to the stars.

> "Natus homo est; illum mundi melioris origo
> Finxit in effigiem moderantûm cuncta deorum."

In the vegetable kingdom, the vital law of development has wrought with less conspicuous effect. The superiority of recent to ancient floras is more significant than striking. A tree-fern or a sigillaria bears comparison with an oak much better than a trilobite or a plesiosaurus with an eagle, horse, or lion. The geological variations of plants, however, have unmistakably tended to make them more serviceable to man—more serviceable to his material needs, and also more gratifying to his æsthetic instincts. For him, flower petals were painted, and perfumes distilled; for him, the grasses of the prairie laid up stores of sustaining nutriment; in preparation for his advent, choice fruits ripened and reddened under Tertiary sunshine; while the barren and sombre vegetation of the Carboniferous epoch had already done its part by dying down into seams of coal for the eventual supply of power for human industry and warmth for human comfort.

It would be an abuse of our readers' patience to discuss the futile conjecture of an extra-terrestrial origin for life on our globe. The agency, in this connection, of germ-laden aërolites was first invoked by Richter of Dresden; and Lord Kelvin gave currency to the notion by an incidental reference to it in 1871 from the Presidential Chair of the British Association. Its adoption would oblige us to regard the denizens of our planet, fauna and flora alike, as salvage from the wreck of some unknown world in space. *Credat Judæus Apella.* To our minds, "all the fables of the legend" appear more credible than the pre-natal history of the primal organism implied by this "wild surmise." Inquiry into the nature of the supposed organism serves to draw closer the web of embarrassment. The remarkable aridity of meteorites excludes the possibility of its having been of aquatic habitat. Members of the fungoid order are unsuited to act as pioneers, owing to their helplessness in the matter of commissariat; and the spores of lichens or mosses could scarcely be expected to survive the vicissitudes of such a journey as they must have performed if meteor-borne to terrestrial shores. The immigration hypothesis, moreover, even if it were plausible, could not be made useful. Difficulties do not vanish on being pushed into a corner; the problem of life is as formidable in one world as in another; we should not expect to find it easier to square the circle in Mars than Deinostratos found it in Greece; matter, we are convinced, has no more psychical initiative in the system of Arcturus than can be ascribed to it in the system of the sun. Profitless conjectures may then be dismissed; they do not help us out of the slough of intellectual impotence.

This need not indeed be absolute. The determination to regard things mechanically alone renders them unintelligible. Science becomes unscientific when it refuses to be guided by experience; and we have the plainest testimony of consciousness to the working in ourselves of originative faculties independent of, and irrepressible by, physical agencies. Here we hold the clue to the labyrinth. The intimation conveyed is distinct of a Power outside nature, continually and inscrutably acting for order, elevation, and vivification.

* *Gifford Lectures*, p. 46.

† *Geology*, Vol. II., p. 22.

Seeing Beneath the Waves.

By the late Rev. J. M. Bacon.

A curious controversy arose fifty years ago concerning the old fable of the "Dog and the Shadow," which opened up the subject of vision through water. On the one side Doctor Lardner maintained that the story, "handed down through so many ages, diffused through so many languages, and taught so universally in the nursery and the school," of a dog being able to see in water the reflection of himself and the meat in his mouth, "was a most gross optical blunder." On the other hand, critics were not found wanting who implied that the fable only represented a fact which ought to be familiar in all possessing ordinary observation. Thereupon the doctor retaliated with an experiment of his own, the futility of which should hardly need pointing out. He filled a basin with water, and, placing it near an open window, looked down upon it from a height of five feet, and saw no trace of his learned countenance therein.

Now, had the doctor simply gone to his water butt, the water within which we will suppose to be clear and not too near the top, and looked in, being careful also that sufficient side light illumined his features, he could have seen quite well enough to shave himself, or by holding a piece of printed paper downwards, not quite squarely but a little slanting, so as to catch the light, he could have had little difficulty in reading any ordinary type. Circumstances would have still further helped this experiment if a projecting roof or tree had overhung, so as to somewhat moderate the overwhelming light background of sky. From this it will be seen that experimenting with a white shallow basin near a window was a ridiculously unfair test of the truth of the old story, whereas were he to have stood over a deep dark overshadowed pool, which might reasonably have been presupposed, he would have found that the gross blunder was hardly in the fable.

But the controversy alluded to elicited some well-established physical facts which supply the argument of the present paper. It was first of all pointed out that the image of the banks of a lake or river viewed by an observer stationed at a considerable distance on the opposite side are very vivid, but become less so if the observer, being, we must suppose, in a boat, begins to approach nearer, the reason being that "when a ray falls so obliquely upon the surface of water as to make with the surface an angle of 15°, nearly a fourth of all the incident rays are reflected."

All this, however, can be stated more simply and intelligibly. All the world knows the difficulty of hitting any object under water with a shot gun. If fired nearly perpendicularly downwards over the side of a boat it is true that the shot will penetrate the water fairly steadily and truly, but it is otherwise if the gun has to be pointed in a slanting direction. In this case the shots enter the water reluctantly, taking only a shallow dive below, and in an extreme position the shots will not enter the water at all, but be reflected sheer off the surface.

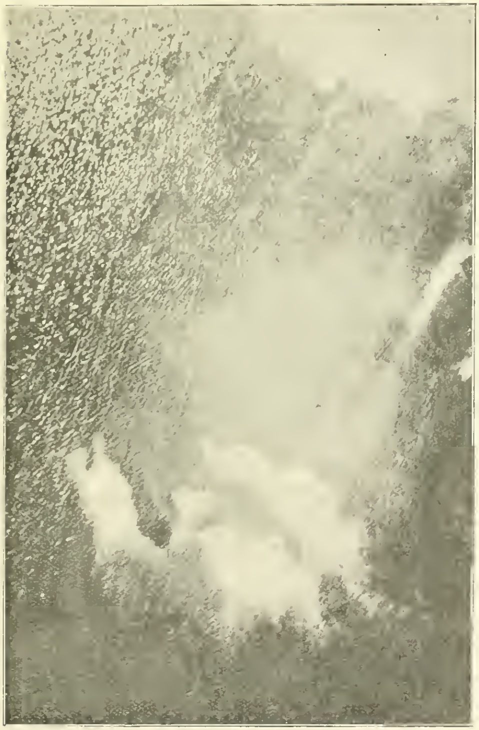
It is practically the same with rays of light, and so it comes about that the image of a distant bank, being seen by rays which are very much aslant, and, therefore, very well reflected, is particularly vivid. And the converse of this is also true, thus—Imagine a sufficiently distinguishable object, say a fish's eye, three feet below clear water. This might be seen readily from a position directly overhead, but less distinctly if viewed at a slant angle, and actual experiment shows that all rays from the fish's eye which are so aslant as to reach the surface of the water beyond a radius of four feet never get out of the water at all, but are simply reflected back from the water's surface, which in this case acts as a perfect mirror. Thus an observer looking towards the fish from a position which is outside this limit will not see the fish, nor—*pace* certain fishermen I have known—will the fish see him. To put this fact beyond dispute let the following experiment be tried. Stand a tumbler nearly full of water on an open newspaper near the edge of a table, and then, placing your eye on a level with the table and six inches from the tumbler, look aslant upwards at the surface of the water. You then learn in a most convincing manner that the water's surface allows no outside rays to pass to your eye, but simply behaves as a mirror, revealing the print of the paper with the most perfect reflection.

We are now prepared to begin an enquiry into a curious and all-important phenomenon which it fell to the lot of the writer to be able to put to a crucial test. It needs no pointing out that in naval warfare, as being carried on at the present hour, there is nothing more deadly or more to be dreaded than the snares which are caused to lurk beneath the water—the mine, the torpedo, and the submarine. It is of paramount importance, therefore, to get, if by any means, some inkling of all that may lie at a moderate distance beneath the water line, and it has long been known that this may best be done by looking down into the water from a considerable height overhead. Even in peaceful navigation, when some danger, as, for instance, a shoal or sunken wreck or the like, is suspected of lying in a vessel's course, but cannot be seen from deck, then it is customary to send a man aloft, and the higher in reason that he can climb the further will his vision penetrate, and the better will his eye command a view of any submerged object. It was to determine the full extent to which this fact could be turned to account that the writer was commissioned under the auspices of the Admiralty to endeavour to obtain photographs of the sea bottom from a balloon. This feat was actually accomplished during an aërial sail over the Irish Sea from the Isle of Man, a voyage which became historical, and which resulted in the securing of a very remarkable photograph of the sea bed, showing varied rock and sand lying in 10 fathoms, that is 60 feet of water, and that water strongly ruffled after a week of boisterous weather.

Now it should be clear that the half of the secret of success in such an attempt has been already told. For if, say, a sunken vessel were lying in a few fathoms of water, and a man were looking down on it from a boat, and floating somewhere just over its middle part, then that middle part might be fairly well seen, but the more distant parts both fore and aft, being viewed at a slant angle, would probably be altogether invisible. If, however, the observer were to be let up a quarter of a mile into the sky, and to look down from there, all parts of the vessel would now lie practically perpendicularly below, and all would be equally well seen.

But in attempting to look beneath the water's surface at sea there is another obstacle to be reckoned with, and that is the usually troubled nature of that surface. For it is an everyday experience that objects which may

be distinct enough below still water become indistinct or invisible if the water be disturbed. To obviate this difficulty it has become customary to make use of a very efficacious and useful instrument called a water telescope, which need be nothing more than a large tube, say a foot in diameter, and say six feet long, closed at one end with a sheet of glass. This end is now plunged beneath the troubled surface of broken water, and the observer applying his eye at the open end is at once able to see as clearly as if the water were unruffled, as, indeed, to his eye it now is.



But let us pass on to consider how it is that the surface of a transparent medium when broken up refuses to allow rays of light to have free passage. Let us take the case of a piece of clear glass, lying on a newspaper, the printed matter of which is then seen with perfect distinctness. But now commence pounding up the glass with a hammer and you find that the more completely the glass is broken up the more is the printed page obscured, and when at last the glass has become mere fine powder, it appears as a white mass like so much salt, and nothing is seen behind it. The fact is that light cannot penetrate the mass, because each ray as it passes from fragment to fragment glances hither and thither off a myriad minute surfaces, and thus wastes itself in a multitude of reflections. In scientific parlance the optical continuity is broken and the mass of powdered glass looks white simply because it only reflects back the white light of day. It would have appeared just as white had the glass been coloured, or even black. In the same way and for the same reason the froth on a glass of Guinness's stout, instead of being dark brown, appears white or nearly so.

We now grasp how it is that without a water telescope it is difficult to see through the surface of troubled water at close quarters, but the fact which we illustrate yet remains, namely, that when the eye is removed to a distance the distraction caused by the broken light largely disappears, and objects below are seen more clearly. Another example strictly analogous of the same sort of thing is afforded by either cloud or mist. Cloud is simply composed of particles of water mingled with particles of air, and though both separately are perfectly transparent, confused together

they form a mass which stops and reflects back the light, and for the same reason the illumined surfaces of clouds are white, but in actual fact the stoppage of light is not so complete as it appears, and a thin veil of mist will behave precisely as the broken water's edge, obliterating the view at short range, but to a more distant observer allowing objects to be seen through it with tolerable distinctness. Thus it often happens that a balloonist whose view of the outside world is wholly obscured by a shroud of thin mist can be quite clearly seen by those at a distance.

It should then be only in accordance with theory and known fact if the secrets of the sea depths, which hide themselves even from the trained eye of the sailor on board ship, should become revealed to an aëronaut who will poise himself in space overhead, say 10 times higher than the maintop.

It scarcely needs the further pointing out that there

is always some of the light which, striking water, is neither reflected nor refracted, but simply scattered. It may sound strange, though it is perfectly true, that were it not for this scattering of light the surface of water would never be seen at all, even in broad day. It is just in the same way that the surface of a polished mirror cannot be seen except where there may be some scratch or smear upon it, and so true is this that in unfamiliar houses we sometimes surprise ourselves by walking up against walls which bear whole length mirrors in unexpected places. In the photograph of the sea bottom it will be noticed that the broken surface of the sea is seen all over the picture, notwithstanding the fact that through it all and below it all the sea floor is seen also.

Once below the surface, however, the ray travels far more readily than is generally supposed. The swimmer who, in diving, is accustomed to open his eyes under water is apt to imagine that very distinct vision is out of the question, but he forgets that the cause of this is due to the disturbance which his own motion is causing in the water. A fish, on the other hand, remaining motionless below, with an eye adapted to its surroundings, may see remarkably well. And on occasions it is brought home to the ordinary observer how well light may pass into clear water, and down to the depths below, and emerge again still in strength enough to ensure good vision. This beautiful phenomenon is particularly noticeable at the far end of some of the Norwegian Fjords, where the sea water has almost parted with its salt, and where no apparent tides disturb the pure and peaceful depths.

It is on looking down into these depths that one curious and not unimportant fact has to be thought of, namely, that they are much deeper than they seem to be. This follows of necessity from what has been already said, namely, that a ray whose path lies partly in air and partly in water takes but a shallow course through the water, a truth which is made perfectly apparent by simply dipping a stick or finger into a basin of water.

An amusing example of this illusion was forcibly impressed upon a friend of the writer, who went to take a morning dip in the swimming bath of an hotel. The hour being early, no one was about, and being long unfamiliar with baths of that description, he took his plunge at an end where the depth appeared perfectly shallow. To his surprise, however, he found himself the next moment in seven feet of water, and then, and not till then, the teaching of his Cambridge days came back to him, and he reproached himself that he had not known better. For the rest it mattered not, for in those olden days Cambridge had not known a stouter swimmer, and, happily, that one art so foreign to man, when once learnt, never deserts him more.

Radiation from Hydrogen Peroxide.

MUCH interest has been caused in Germany by the statement that it was found that photographic plates were affected by hydrogen peroxide, even though screened by thin sheets of metal. It has been suggested, on the other hand, that the hydrogen peroxide is capable of penetrating such screens through minute and inperceptible holes.

The International Catalogue of Scientific Literature.

"THE International Catalogue of Scientific Literature," published for the International Council, by the Royal Society, London—Harrison and Sons. 17 vols. 8vo. Price, £18.

IT is probably known to most of our readers that one of the greatest difficulties encountered in these days by workers in all branches of science is to ascertain what their fellow-workers have lately done and are now doing. This difficulty is greatly increased by the enormous number of scientific periodicals published all over the world. Besides the numerous journals devoted to special subjects, every museum and other scientific institution issues its own "Proceedings" or "Transactions," which often contain scientific information of the most varied character. Taking Zoology, for example, we find in the last volume of the "Zoological Record" a list of the titles upwards of a thousand periodicals devoted to that science alone, and in other branches of science there is probably a corresponding number of publications of this sort, which have to be carefully studied, in order to find out who is working, and what has been written on any particular subject. It is obvious, therefore, that even a catalogue of the titles of published books and papers would be a very great assistance to workers in science.

The idea of forming such a catalogue of scientific books and papers seems to have been first entertained in modern days by the late Dr. Joseph Henry, Secretary of the Smithsonian Institution at Washington. Dr. Henry sent a communication to the meeting of the British Association at Glasgow in 1855, suggesting the formation of a catalogue of Philosophical Memoirs, which was favourably reported upon by a committee appointed to consider it. Two years later, in 1857, the late General Sabine brought the subject before the Royal Society, and requested the co-operation of that Society with the British Association on this matter. After some negotiations the Royal Society ultimately took up the undertaking seriously and published the first volume of their catalogue of scientific papers in 1867. This was subsequently continued until there are now twelve large quarterly volumes which contain the titles, alphabetically arranged according to the authors' names, of all the scientific papers published from 1800 to 1885. On referring to the last report of the Council of the Royal Society we find it announced that the great work of completing this catalogue to the end of 1900 is now making rapid progress, but that the vast bulk of the material to be dealt with has much delayed its issue. When it is finished it will make the "Catalogue of Scientific Papers" complete up to the end of the last century.

The question of the best mode of ensuring the continuance of the catalogue during the present century, having been maturely considered by the Council of the Royal Society, it was determined that this arduous task could best be carried out by the mutual co-operation of all the nations interested in the progress of modern science, and an International Conference was consequently summoned by the Royal Society to consider the question. This Conference took place in London in July, 1896, and was attended by delegates from twenty-one countries. It was unanimously agreed by all the delegates that an "International Catalogue of Scientific

Literature" should be undertaken, and that it should commence on January 1, 1901, where the "Catalogue of Scientific Papers" would come to a conclusion. It was also agreed that the International Catalogue should be controlled by a "Central Bureau" established in London, while the other countries should each have a "Regional Bureau" to collect the necessary information on the spot and transmit it to the Central Bureau. At two other Conferences, held by the Royal Society in London in 1898 and 1900, the scheme was further elaborated, and numerous details were settled. It was agreed that the Catalogue should be published in London in seventeen annual volumes, each of which would relate to a separate branch of science and be distinguished by the letters from A to R. The general plan of the catalogue is given in the subjoined extract from the prospectus of it.

The "International Catalogue of Scientific Literature" contains an Authors' and a classified Subject-Index of the Scientific Literature published on and after January 1, 1901. Each country has undertaken to index its own literature. The material thus collected is sent to the Central Bureau in London, where it is arranged according to (*a*) Authors' Names and (*b*) Subject-matter, and published in annual volumes. A Schedule of Classification and an Index thereto are prefixed to each volume in English, French, German, and Italian. These, and Latin, are the only languages which are used in the Catalogue without a translation, but in the Authors' Catalogue the titles of all publications are given in the original language. Each volume contains the material received at the Central Bureau since the date of completion of the manuscript of the previous volume.

The following is a list of the seventeen volumes (A to R) of the First Annual Issue (1903-4) of the International Catalogue, and of the prices at which they are sold separately; the price of the whole set being £18:—

		Ordinary Volumes. Price.	Thin Paper Volumes. Price.
A	Mathematics	15/-	16/6
B	Mechanics	10/6	12/-
C	Physics (Part I.)	21/-	22/6
	(Part II.)	15/-	16/6
D	Chemistry (Part I.)	21/-	22/6
	(Part II.)	18/-	19/6
E	Astronomy	21/-	22/6
F	Meteorology	15/-	16/6
G	Mineralogy	15/-	16/6
H	Geology	15/-	16/6
J	Geography	15/-	16/6
K	Palæontology	10/6	12/-
L	General Biology	10/6	12/-
M	Botany (Part I.)	21/-	22/6
	(Part II.)	18/-	19/6
N	Zoology	37/6	39/-
O	Human Anatomy	10/6	12/-
P	Physical Anthropology	10/6	12/-
Q	Physiology (Part I.)	21/-	22/6
	(Part II.)	18/-	19/6
R	Bacteriology	21/-	22/6

The second and third Annual Issues are now in progress of publication.

All scientific men will, we think, approve of the general plan of the "International Catalogue of Scientific Literature," and be very grateful to the Royal Society for the institution of a piece of work which cannot fail to be of material assistance in scientific research. But we will now proceed to consider shortly the way in which the initial volumes of the new catalogue have been prepared, and whether they contain the information required by the students of the branches of science to which they respectively relate. To this inquiry, however, we fear it is not possible to give a quite satisfactory reply. While some of the volumes of the first Annual Issue, to which we will confine our remarks, receive unstinted praise, others, it is only right to say, have met with a great deal of severe criticism. In the latter category we may specially point out the volumes on Palæontology and Zoology, both of which are generally considered not to be "up to the mark," as the phrase is. It is, of course, unreasonable to suppose that in commencing the difficult task of inaugurating such a gigantic undertaking as the present mistakes will not be made. We may also be quite sure that Dr. J. Foster Morley, the director of the whole undertaking, and his assistants in the preparation of the long series of volumes have done all in their power to avoid errors. But in some cases they have certainly not altogether succeeded in doing this. It has been shown on competent authority that the list of publications for the year 1901, which is, of course, the most important part of every volume, is by no means complete in the two volumes specified and in several others, and that the subject-indexes are consequently also defective. In the subject-indexes cases of misplaced titles are also by no means rare. These points, we hope, will be more carefully attended to in future volumes. But we venture to recommend that the so-called "Referee" of each volume should be given larger powers for additions and alterations than, as we understand, have hitherto been accorded to him. The Referee should be well paid for his labour, and should be deemed to be absolutely responsible for the correctness of his volume. It is, of course, absurd to suppose that the general editor of the work could be perfectly acquainted with all the sciences to which the seventeen volumes relate, and the responsibility should be attributed to the so-called Referees.

Having said thus much, we will add a few words upon some of the general features of the International Catalogue. In the first place, we object strongly to the shabby paper-covers in which the volumes are issued. They are quite useless for protection, and necessitate the immediate binding of the volumes, in boards at least. To deliver bulky volumes of this kind in thin paper covers seems to us to be a very unbusiness-like proceeding, and likely to hinder their sale. On the other hand, the paper and print of the volumes are decidedly good, though the margin left on each side is, in our opinion, decidedly insufficient. As regards the prices at which the volumes are sold, they are in many cases decidedly exorbitant. Scientific men, we are sorry to say, are seldom possessed of large means. To charge an unfortunate zoologist *thirty-seven shillings and sixpence* as the cost of his volume is, in fact, a prohibition to buying it, and will seriously interfere with the sale of the work. A third point to which we must call attention is the great delay that has taken place in the publication of the volumes. Those relating to 1901 should certainly have all been issued before the close of 1902. Scientific men, like other persons in these days, are always expected to be well "up to date," and cannot be required to wait three or four years for the information they require. Here, again, it may be answered that a new and gigantic undertaking like the present must be allowed a little time to acquire its full organization, and that we should not be too hard on the delay. To this we reply that delay is dangerous in this sort of work. It is often very difficult, if not impossible, to make up arrears, and unless strong means are taken *at once* to bring the "International Catalogue of Scientific Literature" completely up to date, it will lose, we fear, a great part of its undoubted value to workers in science.

The Optical Convention.

THE programme of arrangements for the Convention is now beginning to assume a definite shape, and particulars as to what is at present proposed will no doubt be of interest.

The Convention will be formally opened with an address from the President, Dr. R. T. Glazebrook, M.A., F.R.S., Director of the National Physical Laboratory, on the evening of Tuesday, May the 30th, and the gathering will extend over the four following days, up to and including Saturday, June the 3rd. The mornings will be devoted to papers and discussions, and in view of the interesting series of papers already announced, there is no doubt that this most important section of the proceedings will result in valuable contributions to Optical science, and will fulfil the aims which those who have been active in promoting the Convention have set before them. In addition to the papers, demonstrations of apparatus of special interest will be given in the afternoons in the Laboratories of the Department of Technical Optics of the Northampton Institute.

The Exhibition of optical and scientific instruments will be held in the large Hall of the Northampton Institute, and will be open daily to the public from 12 to 10 p.m., between May 31st and June 3rd inclusive. The charge for admission will be one shilling during the day, and sixpence after 7 p.m.

The Catalogue is now in active preparation. The arrangement made by the "Exhibition and Catalogue" sub Committee that each section should be dealt with by an expert in the construction of the instruments represented in the section, together with an independent scientific member of the Committee, will ensure that all classes of instruments shall be adequately dealt with and described. It is proposed to fix the sale price of the Catalogue, which will be a volume of some 300 quarto pages, at 1s. 6d.; while in large numbers of 100 and upwards, the Catalogues will be issued to firms at a cost of 1s. each. The Hon. Secretary would be glad to hear at once from firms wishing to take a number of the Catalogues for private distribution.

Arrangements for promoting the social interest of the gathering, and for providing for the comfort and convenience of members attending from outside London, are now being considered by a "Hospitality and Entertainments" sub-Committee. In addition to the Presidential address, to be given on the Tuesday evening, which has already been mentioned, there will be an evening lecture by Professor Silvanus P. Thompson, D.Sc., F.R.S., on "The Polarization of Light by Nicol Prisms and their Modern Varieties." On a third evening it is proposed to hold a Conversazione; and for the Saturday afternoon, a visit to the National Physical Laboratory at Teddington is proposed, at the kind invitation of Dr. Glazebrook, the President of the Convention.

Further particulars will be announced later, when the programme is more definitely settled. It will greatly help towards ensuring the social success of the Convention if intending members will send in their applications at once; the subscription for membership is 5s. The Hon. Secretary, Mr. F. J. Selby, Elm Lodge, Teddington, Middlesex, will be glad to hear from those wishing to join the Convention.

The "Local Societies and Representatives" sub-Committee is dealing with the question of facilities for the attendance of visitors from a distance. The Secretary of this Committee is Mr. W. Rosenhain, B.A., 443, Gillott Road, Edgbaston, Birmingham. Mr. Rosenhain will be glad to give information in answer to enquiries, and will also be ready to receive applications for membership of the Convention.

A Curious Induction Experiment.

By CHARLES E. BENHAM.

THE following curious experiment, simple as it is, will probably be new to most readers. Place on a level table two glass tumblers which have been first freed from any superficial moisture by warming them near a fire. Lay a book on each tumbler, the two books being of similar size. The longer sides of the books should be parallel with each other, and the supporting tumblers should be at such a distance apart that the two books are about one inch apart. Place a third book of the same size on a sheet of glass, which must also have been well warmed at the fire. The third book must be laid so that it rests crosswise over the other two, with the sheet of glass

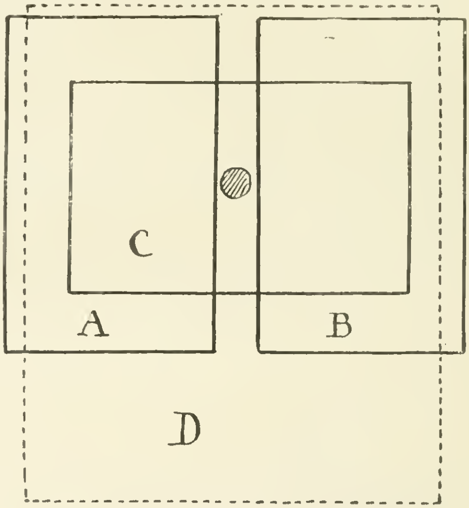


Fig. 1. A and B the two lower books. C the upper book, resting on the glass plate D, and carrying a small coin, laid on the top of the book.

between them, as shown in fig. 1, in which the dotted line represents the piece of glass, the proportionate size of which is thus indicated. On the top book lay a penny, as indicated in the diagram, to act as a conductor for drawing off the electric sparks which are to be produced by this singular arrangement. Now taking the glass carrier, and holding it near the front edge, move it, with its book, horizontally right and left, so that the upper

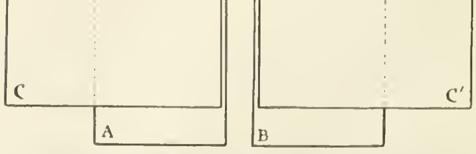


Fig. 2. A and B the two lower books. C the upper book (the supporting glass plate not shown) in its extreme left position. C' the same book in its extreme right position.

book is in turn over each of the lower ones, in the alternate positions shown in fig. 2. Whenever it reaches either of these extreme positions, touch the book underneath it with the finger, taking care not to touch the other book, nor the upper one. When the upper book is in the intermediate position shown in fig. 1 it must be touched, taking care to avoid the earthing of either of the others. Repeat this cycle of movements twelve or twenty times, and then, on lifting the glass plate with its book away from the influence of the other two, a little spark may be drawn from the penny on presenting a finger to it. After drawing the spark replace the plate in the intermediate position (fig. 1), and on earthing the upper book again by touching it as before, its charge will be restored. Continuing the movements, it will be observed that the charge is a growing one, increasing at each cycle, being only limited by leakage from the book corners and by the capacity of the book surfaces. The charge on the upper book may be given up to a Leyden jar each time without loss if the communication from it to the jar is always made previous to its intermediate position, in which, when it is earthed, its loss is made good by induction from the books below. Using large books on the tumblers and, for the upper one, a book of equally extensive surface, though thin for the sake of lightness, quite a strong charge may soon be accumulated in the Leyden jar. If the tumblers and glass sheets are coated with shellac varnish they are less liable to be affected by moisture, and the preliminary warming is unnecessary unless the atmosphere is very damp. The effect is enhanced by using rounded pieces of board instead of the books, and the best effects of all are produced if the conductors are of metal. Three shallow cake tins, about eight inches in diameter, will give very fine sparks, and the snap of the induced charge quickly becomes audible at each successive earthing, the spark of inflowing electricity becoming larger each time until the limit of capacity is reached. The glass will indeed soon become so highly charged that in moving it the cake tin will adhere to it by attraction, while if the lower tins are close together a spark will also frequently fly between them as the upper tin passes from one side to the other. When this happens, however, the process of accumulation is to some extent checked, and the proper distance apart is the shortest distance at which such cross-sparking does not occur.

The experiment is really a modification of one which has already been described and explained in "Knowledge" (November, 1904). Each of the lower books receives an infinitesimal charge by induction from the upper one, which, without losing any of its own, is in its central position enabled, when temporarily earthed by touching, to take up an induced charge from the joint influence of both the under ones. Its original charge is thus multiplied at each cycle. Where that original charge comes from is, of course, a mystery. It is infinitesimal, but it is there somehow, and may be either positive or negative—sometimes one, sometimes the other. It appears that all insulated bodies are at a slightly different potential from earthed bodies, and though it may be difficult to say exactly why they should be, the fact that they are is sufficient to account for the apparent miracle of self-excitement which characterises nearly all induction machines.

Perhaps one of the most interesting suggestions arising from the experiment suggested above is in connection with the phenomena of atmospheric electricity. The effect of the movements of the books is so obviously suggestive of the influence which cloud masses must exert upon each other when one passes over two, with an intervening space to separate them, that there is no resisting the conclusion that in the phenomena of the thunderstorm we frequently witness on a large scale an almost precisely similar experiment of Nature to that which we have been performing on the dining-room table with the three books to represent the cloud masses. Especially suggestive is the flashing of the sparks from one of the lower plates to the other, which occurs, as already mentioned, when they are placed very close together every time the upper plate passes across them. Here undoubtedly we have the very counterpart of the phenomenon often observed in a thunderstorm, when, drawn by the influence of some upper layer of moving cloud, the lightning flash darts across from one charged cloud mass to another in a lower stratum.

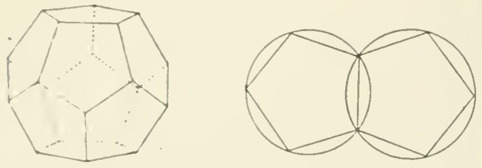
Star Maps.

With this number we present the first of a series of Star maps, which we hope will be found useful to our readers. These charts of the heavens embody some new ideas of design which, while causing the stars to be clearly depicted as they appear in Nature, yet enable the student at once to identify the individual stars and constellations.

One of the most difficult points to decide upon has been the method of projection. It is, of course, impossible to represent all the objects on a spherical surface, such as that which the heavens appear to be to our eyes, in their exact relative positions on a flat piece of paper. If, however, that piece of paper be cut up into a number of small independent planes, each can more accurately represent one portion of the sphere. So if the surface of a globe were cut up into a hundred equal parts, each of them would be practically flat, or if absolutely flattened the position of the stars marked thereon would not be greatly distorted. But such a series of very small maps would be of comparatively little practical use. The principal constellations would be split up into many parts, and their general appearance lost. It is desirable to form the maps in sheets as large as possible, both for convenience of reference and for noting the relative positions of stars and groups of stars. If we find one object on a map we may wish to see in which direction the various neighbouring stars lie, but this would be almost impossible on very small maps. So for practical work we require the maps to be as comprehensive as possible. But any division of the globe into parts has, to some extent, the objection that constellations and other groupings are often divided. This may be overcome by so arranging the maps that they overlap somewhat, and the stars appearing near the borders of one may be repeated on an adjacent map.

Taking all these points into consideration, we believe that no method can be better than that adopted by Proctor in his "Star Atlas" (published in 1870), and it seems appropriate that we should adopt the system first introduced by the founder of "Knowledge." We can but repeat the words of his Introduction. "It is clear that, *cœteris paribus*, that plan is best which represents the celestial sphere in the smallest number of maps. Further the maps should be convenient in size but yet on a sufficiently large scale; and

of two plans, otherwise equal, that one will be best which, on a given scale, and with a given number of maps, makes the maps cover the least possible area. It is also obvious that the distortion and scale variation of a map should be as small as possible." He also says "There is only one plan according to which such an atlas *can* be constructed so as to satisfy even the chief requisites which Star Charts are intended to meet." If the maps are to be of equal size and shape, the surface of the sphere must be approximated by a solid figure composed of a number of faces each forming a polygon. But of these the most suitable is the dodecahedron, or solid figure composed of twelve pentagons. From the figure it will be evident how each one of the pentagons,



though forming a flat plane, will not require that the position of the objects depicted upon them will be much distorted from those on the surface of a sphere. It will be noticed that the distortion is greatest in the angles of the pentagons, so if a circle be circumscribed around the pentagon, the distortion of those parts outside the pentagon will be no greater than those in the angles, and the circle will practically occupy no greater space of paper than the pentagon. By adopting the circle instead of the pentagon we also obtain another important feature, and that is the overlapping of the adjacent maps. In these 12 maps one-fifth of the heavens is included in the overlaps. Occasionally stars lying near, but outside, the border are shown, so as to complete the principal members of a constellation.

Having decided upon this system, the next question was as to the colouring and mode of representing the stars. Most maps mark the stars in black on a lighter ground, the opposite to Nature, and causing much confusion with letters and signs. White stars on a blue ground have therefore been adopted.

The names of the constellations are here put in large letters, so arranged as to cover as far as possible the constellation, and yet being so placed as not to interfere with the individual stars. The lines of R.A. are only given for the hours, though around the border divisions are put corresponding to each ten minutes, and Declination lines are put at each 5 degrees.

As regards the nomenclature of the stars, we have added *names* to all those mentioned in the Comte de Miremont's Popular Star Maps, the *Greek* letters to those recognised by such, and Flamsteed's numbers to others. There remain many other smaller stars, which bear various numbers according to different catalogues, but we have thought it best to leave them unnamed, as otherwise confusion may be caused.

The brilliancy of the stars, known by the misleading designation of "magnitudes," but which, of course, has nothing to do with the actual size of the stars, are here given according to conventional shapes (as shown on each sheet). The actual size represented varies slightly, since the stars are not, as a rule, of any *exact* magnitude. These are entered in accordance with the Harvard Photometry.

The Milky Way has been added in a manner which may not perhaps appear wholly satisfactory, but it becomes a practical difficulty to depict that which is but a mass of stars in such a way as to interfere as little as possible with stars superposed upon it. Many other practical difficulties have appeared during the construction and printing of the first map, but in future we propose to employ a slightly different system, which should secure greater clearness and accuracy.

MAP I.

North Polar Stars.

This is perhaps the most important map of the whole series for several reasons. All the stars here represented are *always* above the horizon in England. One of the chief practical uses in a knowledge of the position of the stars is to be able to ascertain the direction of true north. By becoming conversant with the lie of the chief stars in this region the north point is readily noted. Besides these this map happens to include several of the most conspicuous and easily remembered constellations in the heavens, viz., the Great Bear, the Little Bear, and Cassiopeia.

It may be almost superfluous to mention that the North Pole of the heavens is found by prolonging the line of the "pointers" (β and α *Ursæ Majoris*) towards Polaris, which star stands very much alone, and close to the Pole. If Polaris be joined by an imaginary line to the end of the "tail" of the Great Bear (η) the Pole will be approximately where these two lines cross.

Among the more noteworthy stars and other interesting objects to be found in this map are the following:—

δ *Cephei* (22h. 25m. + 57° 54'). Double. The principal star is variable from 3·7 to 4·9 magnitude, and is a spectroscopic binary of great interest. The variability, in this case, is proved not to be dependent on eclipse obscuration with a darker body, but seems to be due to an actual variation in radiating power.

α *Cassiopeiæ* (oh. 34m. + 55° 59') is a quadrupal and irregular variable ranging from 2·2 to 2·8 mag.

η *Cassiopeiæ* (oh. 43m. + 57° 17'). A binary, the two stars being of 3·5 and 7·5 magnitudes respectively, at a distance apart of 5"·68.

σ *Cassiopeiæ* (23h. 54m. + 55° 12'). A double star, one white, of the 5th magnitude, the other blue of 7·5 magnitude. Distance apart 3"·0.

Perseus, between 9 and 5 are two clusters. Near this point a Nova was discovered in 1895, of the 9th magnitude.

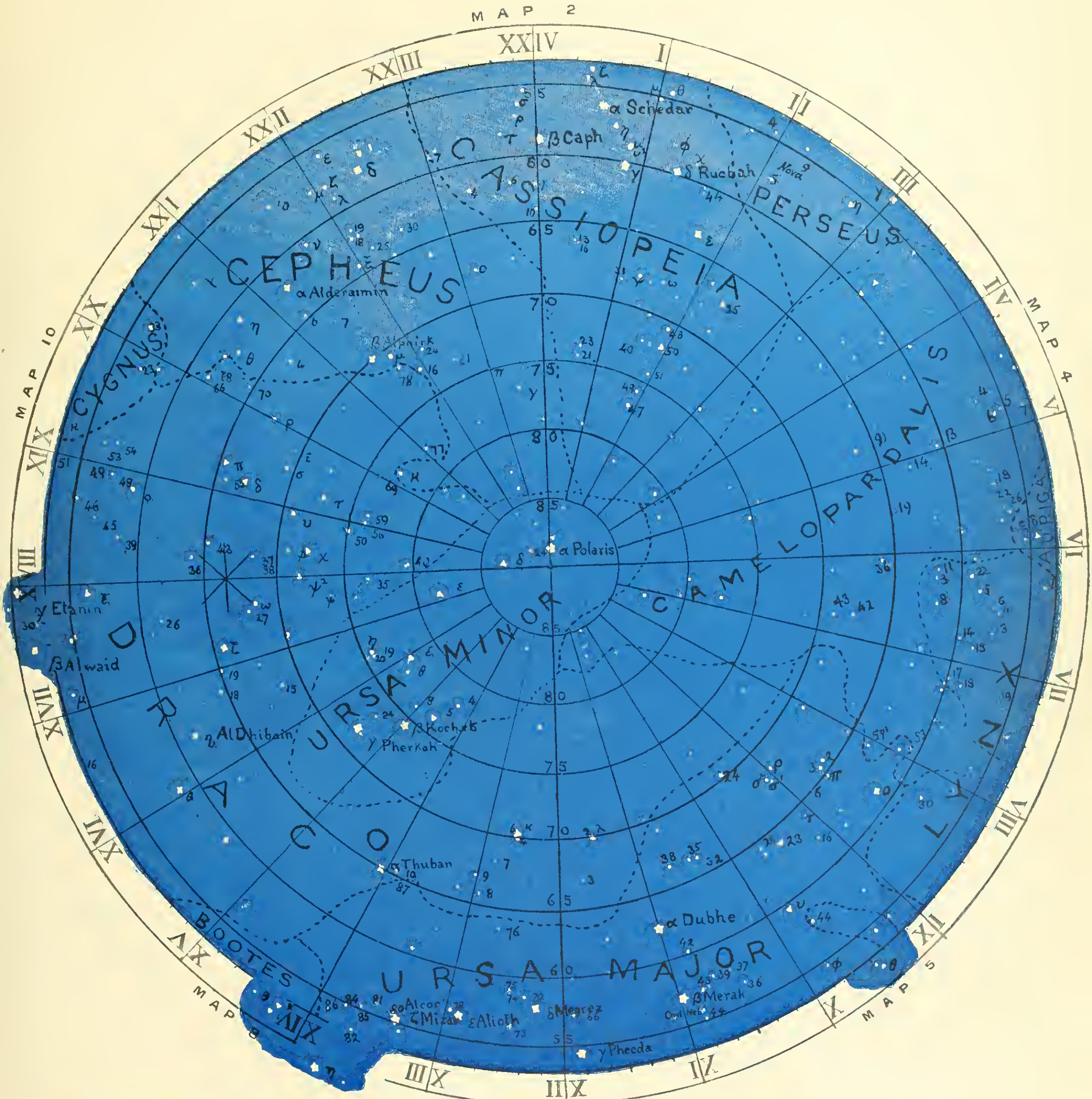
α *Ursæ Minoris*, "Polaris" (1h. 23m. + 88° 46'). Mag. 2·12. This is a double star, the smaller one at a distance of 19" being of 9th magnitude. The larger star is a spectroscopic binary, period 4 days, probably having two dark companion stars.

In *Ursæ Major* close to β is situated the "Owl Nebula" (11h. 9m. + 55° 34') invisible to the naked eye, but by aid of powerful telescopes is seen to consist of two spirals formed in opposite directions.

ζ *Ursæ Majoris*, "Mizar" (13h. 20m. + 55° 26'). A well-known double star, magnitude 2·1 and 4·2, distance apart 14"·4. Position angle 147°·4. The larger star is a spectroscopic binary of two bright and equal components. "Alcor," 5th magnitude, is 11" away from ζ.

Draco. A gaseous nebula, of a pale blue colour, lies close to the north pole of the ecliptic. (17h. 59m. + 66° 38').

From a point in *Perseus* (3h. om. + 57°) come the well-known Perseids, or meteor showers, about the 9th-11th of August.



BRIGHTNESS.

1st Mag.
2nd „
3rd „
4th „
5th „
6th „
Variable.
Nebula.

MAP No. 1.

Northern Polar Stars.

Mammals that Carry Their Young.

By R. Lydekker.

"While taking bats one day in December, I captured a female of our common Buenos Ayrean species (*Molossus bonariensis*), with her two young attached to her, so large that it seemed incredible she should be able to fly and take insects with such a weight to drag her down. The young were about a third less in size than the mother, so that she had to carry a weight greatly exceeding that of her own body. They were fastened to her breast and belly, one on each side, as when first born; and possibly the young bat does not change its position, or move, like the young developed opossum, to other parts of the body, until mature enough to begin an independent life. On forcibly separating them from their parent, I found that they were not yet able to fly, but when set free fluttered feebly to the ground. This bat certainly appeared more burdened with its young than any animal I had ever observed."

Thus wrote Mr. W. H. Hudson in that delightful book, "The Naturalist in La Plata," rather more than a dozen years ago. The passage appears, however, to have been generally overlooked by later naturalists (the present writer among the number), for in 1902 the fact that certain female North American bats habitually carry about with them more than a single offspring clinging to their own bodies was brought to notice as an entirely new discovery. So utterly incredible, indeed, did it appear to naturalists of an earlier date, that a bat should be able to fly with a couple of young ones clinging to her breast, that in 1878 the late Dr. G. E. Dobson expressed the opinion that, in the case of twins, one of the pair might be transferred to the male parent, and carried about by him. Not only, however, has no instance of such a transference ever been observed, but the discovery that female bats are capable of carrying not only two but actually four offspring about with them indicates that, in the great majority of species, it never occurs at all.

The case of the above-mentioned North American bat (*Lasiurus borealis*), of which a full description will be found in "Knowledge" of November, 1903, altogether eclipses the instance quoted by Mr. Hudson, for two specimens of this species have been brought to notice with four young ones clinging to their nipples. And although no one has hitherto taken a female thus loaded in actual flight, from the fact that bats of the genera *Lasiurus* and *Dasypterus* are furnished with two pairs of nipples, it appears probable that a quartette of young ones is commonly carried by the female parent during her aërial wanderings. On the other hand, as European bats have but a single pair of nipples, it may be inferred that the females never carry more than two young, although an instance of even this does not ever appear to have been observed.

As already mentioned, the weight of the twins actually seen to have been carried by the South American species is reported to have greatly exceeded that of her own body. In the case of one of the North American specimens, the weight of the quartette was 12.7 grammes; while that of the mother was only 11 grammes. The offspring in this instance were, however, much younger than in the case recorded by Mr. Hudson, so that it is a fair inference in the instance of the North American species that the weight of the offspring would have eventually doubled that of the parent before the burden was finally discarded. How such a sorely over-burdened mother could have managed to fly at all is little short of a miracle.

From their peculiar mode of life it is, of course, evident that bats of all kinds must habitually carry their young about with them; and in the case of the large fruit-bats, or flying-foxes, which can be easily kept in captivity, it has been observed that in repose the young cling head-downwards to the under surface of the body of the female parent (Fig. 1). In the remarkable naked bat (*Chiromeles torquata*), of the Malay countries, the absence of fur would, however, effectually prevent the young being carried about in the ordinary way; and we accordingly find the nipples enclosed in large pouches of skin, which doubtless form receptacles for the young bats. From the fact that these pouches are present in both sexes, it has been suggested that, in the case of twins, the care of one of the pair is undertaken by the male parent. Even, however, if twins are ever produced by this species, the case of the above-mentioned American bats suggests that no such transference of a share of the burden is essential.

Fig. 1.—Female Fox-Bat with young. (From Sclater, *Proc. Zool. Soc*

Next to these sorely-tried American bats, the most overburdened animals would appear to be the females of the American opossums, some of which are in the habit of carrying their numerous progeny about with them on their backs, as many of the young as can find room securing a firm hold by twisting the tips of their own prehensile tails around the tail of their parent, which, in some instances, at any rate, appears to be bent forward over her back for this special purpose. In the case of one of the larger South American species, which is considerably inferior in size to an average cat, Mr. Hudson tells us that he has seen as many as eleven young ones, each as large as a full-sized rat, carried about on the parental back. In this instance the burden must be proportionately greater than in the case of a terrestrial animal, for these opossums when thus loaded follow their usual practice of climbing swiftly and with the greatest agility among the higher branches of trees. Indeed, it would seem that the creature must capture its prey while thus burdened for the members of the family, like Sinbad's old man of the sea, seem never to voluntarily relinquish their equestrian position until old enough to shift for themselves.

To make the parental back serve the purpose of a perambulator seems, indeed, to be fashionable among South American animals, for Mr. Hudson tells us that the females of the large aquatic rodent of that country locally known as the coypu or nutria (*Myopotamus coypu*) are in the habit of carrying at least some portion of their family while swimming. Not that the little coypus, which usually number eight or nine, cannot swim perfectly well by themselves, but they are probably unable to keep up the pace for any distance, and it is quite common to see as many as can find room comfortably seated on their mother's back, and the rest swimming behind on the look-out for their turn for a ride. Whether beavers and water-voles ever carry their offspring about in this manner I have been unable to ascertain.

It is stated, however, on good authority, that the young hippopotamus is often carried on the back of its mother as she swims, although it is somewhat difficult to imagine how the little creature can maintain a secure foothold on such a slippery surface. Be this as it may, it is evident that the hippo, even though larger

Fig. 2. Female Opossum and Young. (From Elliot's "Mammals of Middle America.")

than a good-sized boy, cannot be much of a burden to its colossal parent. A creature which habitually carries about its offspring on its back is the female koala (*Phascolarctus koala*), the native bear of the Australian colonists, which dwells among the highest branches of the lofty blue gum-trees, where it may be descried on moonlight nights by a practised observer when thus loaded (Fig. 3). The thick woolly coat of the parent affords excellent foothold to the young koala; and since there appears to be never more than one of the latter, the burden to the female cannot be excessive. The koala is a member of the marsupial order, in all the species of which the young are born in a helpless condition, and cling for some time to the nipples of the parent. After this they are usually carried for a period in the pouch in which the nipples are situated. The sojourn of the young koala in the pouch after leaving the nipple, if it takes place at all, must, however, be very short, as the creature takes a seat on the maternal back while still small.

The American opossums are likewise members of the marsupial order, but they present some very remarkable variations in regard to the development of the pouch. The common or typical species, for example, takes its name of *Didelphys marsupialis* from the presence in the female of a large and capacious pouch, in which the numerous members of the family are carried about until they attain a very considerable size and become a serious hindrance to the parent in getting about. On the other hand, in the above-mentioned South American species, commonly known as the thick-tailed opossum (*D. crassicaudata*), and likewise in the much smaller *D. dorsigera*, the pouch is rudimentary and functionless, and the young are carried about on the back of the female parent in the manner already described. Considering that all three species are thoroughly arboreal in their habits, the reason for the loss of the pouch in the two latter seems altogether inexplicable. If the female of one species can climb with her pouch full of young, there is no apparent reason why those of all the species should not be able to do the same; and so far as the young are concerned, they would seem, at all events in the younger stages of their existence, much better off in a nice warm pouch than in a somewhat precarious and decidedly exposed position on their parent's back, where, however, they have much better opportunities of seeing something of the world.

Fig. 3. Female Koala carrying its Cub.

The females of all the species of kangaroos, wallabies, and rat-kangaroos always carry their offspring in the pouch until they are of very considerable size and quite able to look after themselves. In most cases there is only a single young one, but a second may be born before the first has quitted the pouch. In the case of the larger kangaroos, the young, or "Joey," which may be the size of a hare before it finally leaves the pouch, must be a very serious burden to the female when at speed. This is proved by the fact that although when first pursued the female parent will pick up and deposit in the pouch the "Joey" running by her side, yet that when very hard pressed she will not hesitate to eject her offspring and leave it to its fate in the hope of saving her own life.

The cuscuses of the Austro-Malayan islands and the phalangers—the mis-called opossums—of Australia itself, which are thoroughly arboreal creatures, all carry their young in pouches. Although there may occasionally be twins, as a rule there is but one at a birth, so that the mother is not burdened to any excessive extent by her load. Of the breeding habits of the flying-phalangers, or flying-opossums, of Australia, little or nothing seems to have been recorded; but since they have pouches, it may be assumed that the young, which are frequently four in number, are carried about by the female. As to the pigmy flying-phalangers—the flying-mice of the colonists—it is diffi-

cult to know what to say in this connection, as an anonymous writer tells of having seen a family of young ones cut out of a hollow tree without mentioning whether or no they were in the maternal pouch. On the other hand, the bandicoots (*Perameles*) and the native cats, or dasyures (*Dasyurus*), invariably carry their young about in the pouch, although in some of the species of the latter group the offspring make use of that shelter only for a very short period after they have detached themselves from the nipples. Not unfrequently there are six in a litter. Although the members of the Australian genus *Phascologale* are commonly called pouched mice, they scarcely deserve that title, since the pouch is generally reduced to a mere fold in the skin of the under-parts, and the young hold on to their mother mainly by the aid of her long hair, in which they are more or less completely concealed. From eight to ten young ones have been seen clinging to the nipples of their parents; but how long after being able to move about by themselves they cling to the maternal body, and what proportion the united weight of a litter bears to that of the parent, do not appear to have been recorded. Eight or ten little ones, of whatever size, must, however, be a considerable load for a creature no bigger than an ordinary mouse, so that these little marsupials are certainly entitled to be included in the list of heavily-burdened mothers. There are other Australian marsupials which carry their young in the pouch, but these need not be specially mentioned. On the other hand, in the curious banded anteater (*Myrmecobius fasciatus*) the pouch is obsolete, and the young, after becoming detached from the nipples, are probably brought up in some hollow tree. On this point, as well as many others connected with the breeding of marsupials, we are, however, sadly in need of definite information. And here it may be mentioned that few of the numerous collectors who are now sent to all parts of the world to obtain specimens of animals bring back any information with regard to their habits; their sole object being to kill as many innocent and beautiful creatures as possible, and thus add a few more names to the already overburdened list of species and subspecies. The infinitely more important life-histories of the creatures are left alone. This is a great pity, for, without in any way decrying the importance of systematic and anatomical investigations, the life-histories of animals undoubtedly deserve our best attention.

Another Australian mammal, the spiny anteater (*Echidna aculeata*), must receive special mention here, since it is one of the egg-laying group, and during the breeding season the female carries her two eggs about with her in a temporary pouch till they are hatched. In what stage of development the young are hatched does not, however, seem to be ascertained, neither does there appear to be any information with regard to the length of their sojourn in the pouch after hatching.

We have already seen that bats of all kinds habitually carry their young about them until sufficiently old to fly by themselves; and it is obvious that all flying mammals must either follow this practice, or keep their young in nests to which periodical visits are paid. The flying-squirrels (not the marsupials wrongly so-called), which, by the way, do not really fly, but merely take long flying leaps by the aid of the parachute-like expansion of the skin of the flanks, adopt the former plan. On the other hand, the curious flying-lemurs, or cobegos (*Galeopithecus*), of the Malay countries and the Philippines, which also merely take flying leaps, carry their young about with them in the same manner as bats. Dr. A. R. Wallace, for instance, describes shooting a female cobego, to whose breast adhered a small, blind, and naked young one, which reminded the observer of the helpless offspring of marsupials, although it was in a somewhat more developed condition. How long the young cobego makes use of its parent as a kind of flying-machine, and to what extent the mother is hampered by the weight of her offspring, are, however, interesting points in regard to which we have again to deplore a total lack of information.

The only other mammals that habitually carry their young are the members of the order Primates, which includes the human species, apes, monkeys, and lemurs. Among these, except when the task is delegated to the husband, the nursemaid, or the perambulator, the practice is universal on the part of the female; the male apparently never taking upon himself the duties of nurse among mammals other than man. In the case of monkeys and apes the young appear to be generally carried clinging to the breast of their mother or on her back. Some of the lemurs

Fig. 4.—Female Lemur and her Baby. (From Sclater, *Proc. Zool. Soc.*)

at any rate have, however, an altogether peculiar method of carrying their living burden, the young lying transversely across the abdomen of the female parent, with its head on one flank and its tail on the other (Fig. 4). In this strange position the baby lemur is probably carried with less inconvenience than would be the case in any other way; and since the young of these animals appear to be thus carried till they are of comparatively large size, such a consideration is of considerable importance.

In conclusion, it may be mentioned that two points are brought into prominent notice in this article. Firstly, the wonderful amount of care the mothers of many species of mammals devote to the well-being of their offspring, and the amount of physical labour and endurance they are willing to undergo for this object. Secondly, the extremely imperfect state of our knowledge with regard to the breeding habits of many of the species noticed in the foregoing paragraphs, and the urgent need that exists for careful observation on these and other habits if zoology is to be raised to something more than a mere catalogue of species and description of anatomical details.

NOTES.

ASTRONOMICAL.

New Comet 1905 a (Giacobini).

A TELEGRAM received on the 27th March from the Kiel Centralstelle announced the discovery of a new comet at Nice, on the 26th March, by M. Giacobini, for which the following co-ordinates have been furnished:

RA = 86° 3′ 30″ (5 h. 44 m. 14 s.) 1905. March 26·12. 8 h. 11·8 m.
Decl. = + 10° 56′ 56″ Nice Mean Time.

A later telegram confirmed the discovery by the comet being seen at Lick on March 27 in the position:—

RA = 5 h 48 m 55 s. 1905. March 27. 7 h. 57 1 m.
Decl. = + 12° 35′ 43″ (Lick Mean Time.)

The observations indicate that the comet, on discovery, was situated in the North-East of the constellation of Orion, between the stars α and γ, and that it is moving in a north-easterly direction at the following rate:—

Daily motion in RA. = + 45′
" " " Decl. = + 1° 15′

From the observations obtained on March 26, 28, and 30, the following Ephemeris elements have been computed by Herr E. Stromgren.

T = 1905, April 3·2098 (Berlin Mean Time).
ω = 357° 9′·49
Ω = 156° 7′·94 (1905 0)
i = 41° 37′·45
l g q = 0 05232.

* * *

Photography of the Solar Corona in Daylight.

For many years astronomers in all parts of the world have been experimenting with various devices in the endeavour to obtain records of the solar corona at ordinary times, but without success. M. A. Hansky has during the last four years been pursuing this inquiry in the exceptionally favourable atmosphere at the summit of Mont Blanc. He found by preliminary trials that the spectrum of the diffused sky light was very feeble in the red region compared with the intensity of the green and yellow portions. It is a fortunate condition that in the solar spectrum the red rays are relatively less absorbed in their passage through our atmosphere than the more refrangible rays; and as the continuous spectrum of the corona is very intense in the red region, it appeared feasible to attempt photography of the coronal structures by means of these red radiations, obtaining the necessary contrast by passing the light through a screen suitably prepared to cut off all except the red rays. After numerous tests of many aniline dyes in solution, a combination was found which completely absorbed all the spectrum radiations from λ 6600 to the extreme ultra violet, the colours used being red, orange, malachite green, and gentian violet. The absorbing screens were made by steeping fine grained Lumière films, previously fixed without development, in concentrated solutions of the corresponding colours. These were then placed between two glass plates, one with plane parallel faces, the other coated with the usual sensitive emulsion.

An opaque screen slightly larger than the diameter of the solar image was placed on the outer glass plate, so that the light from the brilliant photosphere was prevented from reaching the sensitive plate.

By the permission of M. Janssen, the photographs were made with the 12-inch telescope of the Mont Blanc observatory. On September 3, 1904, twelve photographs were obtained of the circumsolar regions, with exposures varying from 30 seconds to 2 minutes. The positions of the screens were changed so as to eliminate any local effects due to them on the plates. The negatives obtained were copied and secondary negatives obtained by intensification, giving increased contrast, which are stated to show remarkable resemblance to those of the solar corona photographed during total eclipses.

M. Janssen adds a few words in support of the forms thus photographed being truly coronal, and M. Hansky suggests that by a suitable alteration in the colour of the screen used, it may be possible to photograph the images of the prominences in the red light of wave length of the C line of hydrogen.

In a short criticism of this work of Hansky, M. H. Deslandres suggests that it would be a great improvement if special precautions were taken to eliminate the diffused light in the photographic instrument itself. In the apparatus as used, light would be reflected back from the disc cutting out the sun's direct image to the surfaces of the objective, and from these some light must necessarily be again irregularly reflected towards the photographic plate, where it will tend to produce a diffused glow round the edge of the occulting disc. The direct solar radiation is estimated to be about 200,000 times as intense as that of the corona, and if we assume the irregularly reflected and diffused sunlight from the occulting disc and object-glass surfaces to be 1-100th part, it is evident that this would still be far stronger than the corona it is desired to photograph. It is suggested that the occulting screen be placed outside the instrument altogether, at such a distance that it will obscure the sun's disc and also a slight amount of the more intense base of the corona.

* * *

Search Ephemeris for Tempel's Periodic Comet, 1867 II.

It being probable that the periodic comet discovered by Tempel in 1867, and afterwards observed in 1873 and 1879, may return during the present year, M. R. Gautier has prepared a provisional search ephemeris to aid in its identification. There appears to be evidence that the perihelion distance of the comet has been considerably increased by the perturbations induced by Jupiter, the element being almost double its former value in 1867. This factor will probably cause a great diminution in the intrinsic brightness of the comet. It is hoped, however, that the favourable conditions of the coming apparition may permit of its observation; perihelion passage occurs in the spring, a little before opposition. There is a slight uncertainty of ± 12 days in the epoch of perihelion passage, and the ephemeris is therefore given for each of the extreme times in addition to the more probable mean values. The following are the elements on which the ephemeris co-ordinates are based:—

T = 1905 April 20·5 Berlin mean time.
μ = 542″·68.
φ = 23° 42′·0.
i = 10° 47′·2. ⎫
Ω = 72° 41′·7. ⎬ (mean equinox 1905.)
ω = 168° 40′·3. ⎭

For preliminary purposes until the comet be sighted it will be sufficient to give the positions for every fourth day.

Ephemeris for Berlin mean Midnight.

1905.	T = May 2·5 R.A.	T = May 2·5 Decl.	T = April 20·5 R.A.	T = April 20·5 Decl.	T = April 8·5 R.A.	T = April 8·5 Decl.
	H. M. S.	° ′	H. M. S.	° ′	H. M. S.	° ′
May—						
2·5	17 9 55	-19 14·6	17 40 58	-21 16·5	18 10 31	-22 48·1
6·5	9 13	39·7	41 13	43·4	11 44	23 15·1
10·5	8 1	20 5·8	40 56	22 11·4	12 25	43·5
14·5	6 20	32·9	40 8	40·4	12 33	24 13·3
18·5	4 14	21 0·7	38 50	23 10·3	12 9	44·1
22·5	1 45	28·9	37 4	40·9	11 13	25 16·0
26·5	16 58 5	57·4	34 52	24 11·9	9 18	48·5
30·5	55 57	22 26·0	32 18	43·0	7 53	26 21·5
June—						
3·5	52 48	51·3	29 26	25 13·9	5 34	54·5
7·5	49 37	23 22·2	26 22	44·2	2 54	27 27·1
11·5	46 29	49·4	23 11	26 13·5	17 59 58	58·9
15·5	16 43 30	-24 15·9	17 19 59	-26 41·6	17 56 50	-28 29·5

CHEMICAL.

By C. A. Mitchell, B.A. (Oxon.), F.I.C.

Application of the Serum Test to Mummies.

Dr. Uhlenhut, of the Hygienic Institute of Greifswald, has attempted to determine the origin of mummy material by means of the specific serum test of which a description was given in "Knowledge & Scientific News" (this vol., p. 86). For this purpose aqueous extracts were made of a large number of mummies ranging from 1000 to 3000 years in age. It was found that these were strongly acid and gave a turbidity with *normal* rabbits' serum, but that when the acidity was neutralised they gave no reaction either with normal serum or with the *præcipitines* that had been rendered specific for human or other serum. This was eventually shown to be due to the fact that these extracts did not contain any albuminous substances, which if still present in the mummies were no longer soluble in water. On the other hand, mummies of comparatively recent date (up to 66 years) yielded extracts that at once showed their origin by giving pronounced precipitates with specific sera.

* * *

Ancient British Gunpowder.

In the course of excavations made at the beginning of this year in the public square of St. Martin-de-Ré (Charente Inférieur) the workmen unearthed trenches in which lay skeletons, presumably of those who fell when the town was besieged by the English in 1627. Among the *débris* was found a spherical iron bomb containing a moist black powder, which had been fired by the besiegers and had failed to explode. The powder, of which a specimen has been examined by M. L. Desvergnes, ignited readily after being dried, and was found to consist of about a third of nitre, a third of carbon, and a fifth of sulphur, the remainder being iron oxide derived from the rusting of the iron shell. After making allowance for this iron oxide and for the fact that a large proportion of the nitre must have been dissolved out by the water, these analytical results are in agreement with the composition of old English military gunpowder, which contained approximately 75 parts of nitre, 15 parts of carbon, and 10 parts of sulphur.

* * *

The Phosphorescence of Phosphorus.

Recent experiments made by Herr Jungfleisch show that the phosphorescence of phosphorus is due to the formation of an oxide. Thus if an inert gas such as nitrogen be passed over phosphorus contained in a vessel the vapour issuing into the air is only faintly luminous, but the admission of a minute trace of oxygen with the gas causes the phosphorus to phosphoresce and enormously increases the luminosity of the vapour. The oxide can be condensed by cold, for phosphorus vapour is rendered non-luminous by being passed through a vessel cooled to 50° F., while an inert gas subsequently passed through this vessel at a temperature of 60° F. becomes phosphorescent.

* * *

Luminescent Zinc Blende.

Zinc blende which possesses the curious property of luminescence has been discovered in California, Nevada, and other States of North America. The ore has a flaky structure, and varies in colour from light to dark grey. It consists, in the main, of a mixture of white barite (barium sulphate) and brown sphalerite (zinc blende), and also contains a considerable amount of gold and about 4 ozs. of silver per ton. It is not radio-active, but when scratched with a knife in the dark emits a series of sparks forming a line of light which follows the point of the blade.

* * *

Oxydases and their Work.

Everyone is familiar with the discoloration that takes place in a cut apple or potato on exposure to the air, and there are many analogous phenomena in the vegetable world. Thus several species of fungi, such as *Boletus luridus*, turn blue when broken, whilst beetroot rapidly darkens under the same conditions. In each case such changes are to be attributed to the oxidation of certain constituents within the plant, a combination with the oxygen of the air being brought about through the agency of certain organised ferments or enzymes termed *oxydases*. An enzyme may be defined as the material substratum of a peculiar form of energy produced by living cells, from which it is more or less separable. Oxydases, like other enzymes, such as the *pepsin* of the gastric juice, and the *diastases* of the saliva and of malt which convert starch into sugar, have not yet been isolated in a pure condition. Impure solid preparations have been obtained by treating the juice of the plant with alcohol and subjecting the precipitate to further purification. MM. Chodat and Bach have recently prepared very active and relatively pure oxydases from different fungi, &c., and find that they are not albuminous substances. The activity of oxydases is destroyed by heat, and thus a baked apple or boiled potato can be exposed to the air without darkening in colour. A general test employed to detect oxydases is based upon their behaviour with gum guaiacum tincture. Some, the *direct oxydases*, cause it to turn blue by combination with atmospheric oxygen, while others, termed *indirect oxydases*, only give the blue coloration when hydrogen peroxide is also present. This reaction is employed by M. E. Payet as a means of distinguishing between gum arabic and gum tragacanth. The former contains an oxydase and gives the blue coloration, while the latter produces no effect upon the guaiacum tincture. Oxydases are also produced by animal cells. Thus they have been detected in milk, in blood, in saliva, in the gills of the oyster and other molluscs and in the internal organs of many animals; and Dr. Dubois attributes the phosphorescence of the glow worm or other animals to the action of an oxydase, to which he gives the poetic name of *luciferase*.

GEOLOGICAL.

By Edward A. Martin, F.G.S.

Oscillations of Shore-Lines.

Glacialists will feel considerable interest in Dr. Nansen's paper on this subject, which he read before the members of the Research Department of the Royal Geographical Society. Most of his illustrations appear to have been drawn from recent vertical movements of the Norwegian coast. This is, of course, closely bound up with the history of the Glacial Period, and apparently he has no difficulty in subscribing to the views of most modern geologists as to the great downward movement which occurred, at the greatest period of glaciation, in northern and north-western Europe, and if this view once be universally accepted we need go no farther for an explanation of the arctic-shell-bearing beds, which have been found at 1400 feet above the sea, and at lesser heights, at Moel Tryfaen, Gloppa, Macclesfield, and other places. It would be interesting to know how he views the suggestion, admittedly to some extent borne out by observations made during the last few years in Spitzbergen, that these shell beds were pushed or floated upward by ice, the molluscs not having themselves actually lived *in situ*.

Dr. Nansen stated that 42 per cent. of the continental surface of the earth stands between 600 feet above and 600 feet below sea-level, and adduces this fact to maintain that during a long geological period shore-lines have been at very much the same level as now. But though the coast line of Norway had been depressed in places 700 feet below its present level, in Dr. Nansen's opinion, because the land had been pressed down by the weight of the great ice-cap, yet in other places the depression had been very much less, viz., 30 feet to 60 feet. It was remarkable, however, that the land appeared to have a tendency to a certain mean position of equilibrium; and that, in spite of this great difference in the amount of depression, the coast had afterwards come to be at almost exactly the same level as that at which it stood previous to depression. On the subject of an actual rising of the surface of the ocean during recent geological times a decision must be postponed for the production of future evidence. An accumulation of ice around the North Pole might so shift the centre of gravity of the earth as to cause a rise of the ocean around our coasts. If, now that the Glacial Period is long past and gone, there

remains a rise in the level of the ocean, then presumably the tail-end of that period still remains, and there is now more ice in Arctic regions than there was in those times immediately preceding the period. This is to some extent borne out, of course, by the fossil plant-remains of tertiary age, which have been found within the Arctic circle.

* * *

Drift Deposits.

In a paper on the Superficial Deposits of Central and Southern England, Dr. A. E. Salter, F.G.S., has summarised the various drift deposits over the area mentioned. The reprint of the paper, which was read before the Geologists' Association, will prove of great use to students of these surface accumulations. I should like to see more attention paid to the Merstham Gap in the North Downs, for, although the stream which cut it before the Weald was denuded has long been captured by the Mole, there is no doubt that the two intermittent bournes, from the gap, and along the Caterham Valley, represent all that is left of the river system of which the Merstham Gap is the chief visible work. Prestwich's thin covering of gravel at "West Ho, near Norwood," referred to by Dr. Salter, is much thicker than he knew. I have described elsewhere the gravel which extends from Westow Hill, Upper Norwood, south to Grange Hill, and some reputed palæoliths, and, according to some geologists, eoliths, have been found in sub-angular gravel at the top of South Norwood Hill, at 370 feet O. D. The high-level gravels of Upper Norwood are an important geological feature of days contemporary, I believe, with the existence of the arch of the great Wealden anticline.

* * *

Geological Maps and Samples.

Geologists may perhaps be interested in knowing that geological maps can now be ordered at most of the large post offices in London, as well as at head offices in the Provinces. Indexes and small specimen maps are kept at upwards of 700 head post offices throughout the country. The foreign sample post is an excellent medium for the transmission of geological specimens to and from abroad, natural history specimens, generally, being allowed by the authorities at the cheap rate of 4 ounces for one penny, when prepaid within the United Kingdom They must not, however, be sent as articles of commerce.

* * *

Coal-Measure Classification.

On April 13th, a paper was read before the Geological Society of London by Mr. Robert Kideston, F.G.S., on "The Divisions and Correlation of the Upper Portion of the Coal-Measures." A new classification was proposed, by which the Upper Coal Measures were to be known as the Radstockian Series, a Transition Series as the Staffordian Series, the Middle Coal-Measures as the Westphalian Series, and the Lower Coal-Measures and Millstone grit as the Lanarkian Series. The proposed substitution of new terms for those which have obtained hitherto did not meet with much approval, and we sympathise with the protest which was made against the introduction of new terms, except under conditions of the strongest necessity.

* * *

The Phosphatic Chalk at Taplow.

A further paper read at the same meeting dealt with the "Age and Relations of the Phosphatic Chalk of Taplow," by H. J. O. White, F.G.S., and Llewellyn Treacher, F.G.S. The rocks were described in detail, and the following classification was adopted :—

			Feet.
E.	Upper White Chalk	(visible)	16
D.	Upper Brown Chalk, or rich phosphatic band	about	8
C.	Middle White Chalk	,,	16
B.	Lower Brown Chalk, or rich phosphatic band	about	4
A.	Lower White Chalk	(visible)	17

The Lower White Chalk includes a thin layer of tabular flint and one of elongated nodular flints, and the first signs of phosphatic material were observed a few inches below the tabular seam. Attention was drawn to the presence of phosphatic nodules and concretions at certain horizons; and the authors concluded that the Lower White Chalk belongs to the zone of *Micraster cor-anguinum*, and the succeeding beds to that of *Marsupites testudinarius* ; while the lower phosphate-band represents the lower part of the *Uintacrinus*-band, and the upper one that of the *Marsupites*-band of that zone. In each phosphate-band the base is quite sharp, being defined by a rock-bed in the Chalk ; but the upper limit is very ill-marked. The Middle White Chalk is in part divided into lenticles with slickensided surfaces. The authors found *Actinocamax verus* in B, and *A. granulatus* in D and E, but not *A. quadratus* in any bed. Phosphatization is not confined to the foraminifera, and other microscopic remains, but occurs in all shells and structures which are readily penetrable, although not so markedly in those of a more homogeneous character. *Scalaria* occurs in division E, the upper part of which may possibly just include the base of the zone of *Actinocamax quadratus*, or at any rate may not be many feet below that base. The distribution, numerical proportion, and, to some extent also, the morphological character of the microscopic fossils of the Phosphatic Chalk are exceptional. The authors of the papers think that a part, at least, of the phosphatized material has acquired its distinctive mineralogical character on the spot. So far as can be ascertained from existing data, the Phosphatic Chalk is confined to a small tract of country measuring less than 3½ miles from north-east to south-west by less than 1 mile from north-west to south-east.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Doom of the Penguin.

THE Penguins of Macquarie Island and the desolate Aucklands are in danger of extermination at the hands of the company promoter, and this fate will certainly overtake them unless steps are taken to save them.

Dr. E. A. Wilson points out that for some years past a considerable trade has gone on in the preparation of penguin oil, which is obtained by casting these unfortunate birds by the thousand into the melting-pot and boiling them down. No less than 100 tons of oil so procured has recently been placed on the market. Encouraged by success, a scheme is now afoot whereby cauldrons are to be set up on the Auckland Islands to facilitate this nefarious traffic. Hitherto the "rookeries" of these Islands have suffered comparatively little ; but once the cauldron fires are lighted they will not be allowed to die out till the last survivor of the host has been flung into the seething broth. Surely no effort should be spared to frustrate this diabolical scheme.

* * *

A Great Egg Collection.

Our oological readers will be glad to know that Mr. Radcliffe Saunders has just presented his collection of 10,000 eggs to the Natural History Museum at South Kensington. This is the second donation of 10,000 eggs that Mr. Saunders has sent to the Museum. His last gift includes many rarities. The Raptorial series is complete, and so also is that of the crows, crossbills, and buntings. The collection of cuckoos' eggs (*Cuculus canorus*) is especially fine, numbering over 300 specimens. Their value is greatly enhanced by the fact that they have in every case been preserved with those of the hosts destined to hatch them.

The generosity displayed by Mr. Saunders cannot be easily over-estimated. He has placed at the disposal of oologists the world over a collection brought together with the most exacting surveillance. Till now, only a favoured few could derive any profit from these labours henceforth all may benefit who will.

* * *

Hairy Waterhen at Bury St. Edmunds.

The *Zoologist*, for March, records the capture of one of those curious variations of the waterhen which occurs from time to time, wherein the feathers acquire a peculiarly loose structure, comparable to that which obtains in Ratite birds. In colour, this bird, as in other cases of this kind, is described as of a warm sandy-brown above, and greyish-white

beneath. The head and throat were normal both as to colour and the structure of the feathers. The bird was killed in January last, and is described as immature.

This makes the thirteenth recorded instance of this variation in the water-hen. So far, no really satisfactory explanation has been given of this curious "sport." Microscopic examination of the feathers shows that they are always much abraded, the tips of the shafts being broken off. The loose character of the feathers is due to the absence of barbules.

Partially "hairy" varieties of this type have been recorded in hawks and gulls, and in the case of a jacana and a grey Brahma hen.

Should any of our readers come across a similar variation of this kind in a freshly-killed specimen, we would suggest that a careful note should be taken of the colour of the eyes, skin, and bones.

* * *

Arrival of Summer Birds.

From the *Field*, April 15, we gather the following:—

Ring Ousel	Windermere, April 5.
Blackcap	Wellington College, Berks, April 9.
,,	Mitcham, Surrey, April 13.
Wryneck	Rayleigh, Essex, April 1.
Whitethroat	Tooting Common, April 11.
Redstart	,, ,, April 12.
Swallow	Exeter, March 23.
,,	Upwey, Dorset, April 1.
,,	Kettering, April 1.
,,	Eastbourne, April 1.
Martin	Kettering, April 1.
Willow-wren	Tooting Common, April 1.
,,	Walsall, April 1.
Cuckoo	Horsham, April 1.
,,	Beaminster, Dorset, April 1.
Yellow wagtail	Axminster, March 11.
Tree-pipit	Wellington, April 4.
Stone Curlew	Warminster, March 27.
Common Sandpiper	Near Builth, April 4.

ZOOLOGICAL.

By R. Lydekker.

The Subterranean Texas Salamander.

Eleven years ago several specimens of a very curious blind salamander were thrown up from a great depth by an artesian well in Texas, and were subsequently described as representing a new genus and species under the name of *Typhlomolge rathbuni*. Hitherto they have been generally regarded as related to the blind proteus, or olm, of the subterranean waters of Carniolo, whose habits were so well described years ago by Sir Humphry Davy. A lady worker, Miss Emerson, writing in the *Proceedings* of the Boston (U.S.A.) Natural History Society, has, however, come to the conclusion that this is a mistake, and that the creature (which she regards as a persistent larval form like the axolotl) is really a cousin of the common American salamanders of the genus *spelerpes*. So much for external resemblances.

* * *

Miscellaneous Items.

According to a French naturalist, Mr. H. G. de Kerville, an Indian palm-civet (*Paradoxurus hermaphroditus*) recently lived for a year and a half in a forest in Normandy. The creature had in all probability escaped from a passing ship, but it is certainly remarkable that such an essentially tropical animal should have made itself so thoroughly at home in this part of Europe. The new Orkney vole continues to attract much interest on the part of naturalists, Messrs. Clarke and Bradley discussing its affinities in the January number of the *Annals of Scottish Natural History*; while Dr. Forsyth-Major gives his views in the March issue of the *Annals and Magazine of Natural History*. The two views do not, however, altogether agree, the first paper suggesting that the creature is in some respects intermediate between the water-vole and the field-vole; while in the second it is urged that its relationships are solely with the latter and its Continental representative. In the *Zoologist* for April the present writer describes two new species of Oriental gorals, or goat-like antelopes, the one from the Western Himalaya, and the other from Burma.

* * *

Skeleton of the Okapi.

A recent issue of the *Bulletin* of the Malacological Society of Belgium contains a figure and description of the skeleton of a male okapi which has just been mounted for the museum at Antwerp. The structure of this skeleton is said to indicate an animal adapted to live in thick forest, and whose body can pass between tree trunks separated only by a very narrow space. All this is perfectly in harmony with the description which appeared not long ago in a German periodical of the natural haunts of the okapi.

* * *

Papers Read.

At the meeting of the Zoological Society on March 21st, Mr. R. I. Pocock read a paper on the effects of certain abnormal conditions on the horns of the American prongbuck, or prong-horned antelope, in captivity. On the same occasion Sir H. H. Johnston discussed the mammals and birds of Liberia, pointing out that although this district was closely connected with Sierra Leone on the one hand and with the Ivory Coast on the other, yet that it seemed to possess certain peculiarities of its own with regard to fauna and flora. Mr. M. A. C. Hinton, at the same meeting, described certain subfossil red deer antlers; while Dr. R. Brown contributed notes on the affinities of the extinct South African reptile *Procolophon*. At the meeting of the same Society on April 18th, the following three papers were down for reading, viz., Mr. A. E. Shipley on entoparasites from the Zoological Gardens and elsewhere, Dr. E. Lönnberg on hybrids between the common and the mountain hare from Southern Sweden, and Mr. R. H. Burne on the anatomy of the leathery turtle, or luth.

REVIEWS OF BOOKS.

Neolithic Dew-Ponds and Cattle-Ways, by A. J. Hubbard, M.D., and George Hubbard, F.S.A., F.R.I.B.A. Pp. 71. 25 illustrations. (Longmans, Green, and Co.) Price 3s. 6d. net. In this thin small-quarto the authors deal with the evidence which we have of prehistoric man in England in certain well-known dew-ponds, and in the cattle-ways, sometimes made by human hands and sometimes probably by wild cattle themselves, which lead to certain recognised watering-places. The book deals more particularly with considerations concerning Cissbury, Chanctonbury, and Maumbury Rings, Maiden Castle, near Dorchester, Ogbury Camp, and Figsbury Ring. We are not sure the authors are altogether justified in applying the term "neolithic" to all of them, and we think the balance of probabilities goes to show that Stonehenge is just as likely to be of neolithic workmanship as any of the great earth-embankments and trenches to which the authors refer. We cannot agree in assigning so recent a date to Stonehenge as 1800 B.C. The authors have been at great patience in tracing out what remains of the great Rings with which they deal, although they make no claim to have treated the subject exhaustively. Other well-known Rings will perhaps be dealt with at some future date. The book is fully illustrated, and many of the photographic reproductions are full-plate, and admirably illustrate the text.

The subject of the formation of dew-ponds is interesting, and the authors are apparently correct in assigning a great age to them. We are told that in this country there is at least one wandering gang of men, who will construct for the modern farmer a dew-pond, which will contain more water in the heat of summer than during the winter rains. The space hollowed out for the purpose is first thickly covered with a coating of dry straw. The straw is in turn covered by well-chosen, finely-puddled clay, and the upper surface of the clay is then closely strewn with stones. The margin of the straw has to be effectually protected by clay, since if it become wet it will cease to attract the dew, as it ceases to act as a non-conductor of heat and becomes of the same temperature as the surrounding

earth. The puddled clay is chilled by the process of evaporation, and the dry straw prevents the heat of the earth after a hot day from warming the clay.

We remember hearing some time ago that a well-known professor was accumulating material for a book on "dew-ponds," but the work is apparently yet in the future. The manner of their formation, as shown in the book under review, is a distinct contribution to science. There appears every evidence to show that many of the ringed embankments and clusters of artificially-planted trees were connected with the worship of the sun, and this connection might well be worked out thoroughly. We are not sure that the authors have not built up rather much upon little, in seeing the former existence of watch-houses and guard-houses in what are merely depressions in the ground. That the Romans utilised the embankments in many instances we have evidence in the tiles and other remains which have been discovered on the sites. We have doubts as to the amount of protection which the embankments gave to men and cattle from wolves or human enemies. They would serve to conceal their occupants, but would they not also serve to conceal the enemy, whatever it was, when it came? In some cases the earth-walls would be far more serviceable in protecting half-naked men and women from the biting winds which cut across the downs and are practically always blowing. This is frequently overlooked. In conclusion, we would refer to the plate on page 69, and would point out that what look like cattle-tracks may be merely caused by the slipping of clay-with-flints upon the chalk. When overgrown with tufts of grass, this has a tendency to form long terraces, and in the distance these sometimes look like a series of step-like tracks. E. A. M.

Resistance of Air and the Question of Flying, by Arnold Samuelson (Spon); price, 2s. net.—This is a work of considerable value, not so much for the information contained within it as for the suggestions which may be brought to mind on reading it. It is one of the very few books which have been written recently on this subject, and gives in concise form many of the latest theories and facts concerning it. But the reader must not take for granted all the statements here made. Many of them are but opinions held by the author, and not shared by other authorities. In fact, he states: "I dare not expect that the whole world will at once agree with me," although he lays down dogmatic assertions which might easily mislead those anxious to learn. The author is, of course, German, and the main portion of the pamphlet consists of a lecture delivered by him, presumably in Hamburg. It is a pity that the MS. was not looked over by an Englishman, as there are many expressions and sentences which are a little obscure.

Report of the Bureau of American Ethnology, 1900-1901; parts 1 and 2. (Washington: Government Printing Office.).—These splendid volumes, profusely illustrated with coloured and other plates, exhibit a thoroughness of detail and painstaking work such as is seldom seen in these days of hurried production. The report consists chiefly of three "papers," the nature of which may be gathered when we say that the first, "Two Summers' Work in Pueblo Ruins," by Jesse Walter Fewkes, consists of 195 large pages with 122 illustrations in the text, and no less than 70 beautifully-executed full-page plates. The other two papers, "Mayan Calendar Systems," by Cyrus Thomas, and "Hako, a Pawnee Ceremony," by Alice C. Fletcher, are almost as long and complete. The first paper comprises the report of archæological field work conducted at a ruin called Homolobi, near Winslow, Arizona, and later at ruins on the Little Colorado River, and at Chaves Pass and other places. A large number, in all 1824 objects, were collected from the excavations, mostly of a mortuary nature from the cemeteries, about half of which were preserved entire, and many of the others in pieces which could be satisfactorily joined together. These objects include vases and bowls of pottery, shell and stone ornaments, bone implements, matting and basketry, stone implements, &c. The illustrations comprise photographs of ruins and coloured representations of the pottery and other objects. The paper on the "Mayan Calendar Systems" is in continuation of one upon the same subject in the 19th Report, but the investigations at the ruins at Quirigua added much to the subject, the results of which are now given. This account should be of great interest to those investigating the calendar systems and calculation methods of the ancients. The account of the Hako religious ceremony is the result of four years of study in collaboration with an educated Pawnee, and is very complete. Among other items, the songs forming a feature of the ceremony were recorded by graphophone, and the music, transcribed from the cylinders, is here given.

Gas Producers for Power Purposes, by W. A. Tookey (Percival Marshall), price 1s., is a small practical handbook for "purchasers, erectors, and attendants," which should prove most useful to the many persons who may now be included in such a category. Full illustrated descriptions are given of the various methods of generating "Producer" and other gases.

Radium, and all about it, by S. R. Bottone (Whittaker and Co.), price 1s. net, is the second and revised edition of a small book which we reviewed recently. It is satisfactory to see that so much public interest is taken in the subject.

The Trojan Women of Euripides.—Translated into English verse by Gilbert Murray, M.A., LL.D. (George Allen), 2s. net. Copious explanatory notes are added.

Second Stage Magnetism and Electricity.—By R. Wallace Stewart, D. Sc., Lond. (University Tutorial Press). Second edition (re-written and enlarged). This little book is primarily intended for candidates who are preparing for the second stage examination under the Board of Education, and will be found to be a reliable and clear guide for them. Plenty of illustrations are provided. The index is not as complete as it might be, as we notice the absence of the words "accumulator," "secondary battery," "incandescent lamp," "coil," &c., which subjects are, however, well described in the book.

BOOKS RECEIVED.

Ambidexterity, by John Jackson. (Kegan Paul.)

Astronomers of To-day, by Hector Macpherson, Jun. (Gall and Inglis.)

Students' Textbook of Zoology, by Adam Sedgwick. (Swan, Sonnenschein.)

Unbeaten Tracks in Japan, by Isabella L. Bird. (Murray.)

The Hawaiian Archipelago, by Isabella L. Bird (Mrs. Bishop). (Murray.)

Natural History in Zoological Gardens, by F. E. Beddard. (Constable.)

What Do We Know Concerning Electricity? by A. Zimmern. (Methuen.)

Modern Theory of Physical Phenomena, by Augusto Righi. (Macmillan.)

The Electro-magnet. C. R. Underhill. (New York: Van Nostrand.)

Introductory Mathematics, by R. B. Morgan. (Blackie.)

Electro-magnetic Theory of Light, by C. E. Curry, Ph.D. (Macmillan.)

Divine Dual Government, by W. W. Smyth. (H. Marshall.)

Elementary Microscopy, by F. Shillington Scales. (Baillière, Tyndall.)

Moths and Butterflies, by Mary C. Dickerson. (Boston: Ginn.)

Our Stellar Universe, by T. E. Heath. (King, Sell, and Olding.)

Pattern Making, by J. E. Dangerfield. (Dawbarn and Ward.)

Preparatory Course of Geometry, by W. P. Workman and A. C. Cracknell. (Clive.)

Positive Knowledge, by J. Logan Lobley.

Poisonous Plants, by A. Bernard Smith. (Bristol: J. Wright.)

The Harveian Oration, 1904, by Richard Caton, M.D.

Zodiacs and Planispheres, by the Rev. A. B. Grimaldi. (Gall and Inglis.)

Annual Report of the Royal Society of St. George.

The Iron and Steel Magazine. (Boston, Mass.)

Petrol Motors Simply Explained, by T. H. Hawley. (Percival Marshall.)

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Photographic Photometry.—It may seem to be a very obvious suggestion and a very simple matter, seeing that an increase of brightness of the light that impinges upon a photographic plate, causes an increase in the darkness of the resulting deposit, to use a photographic method for the purpose of comparing the brightness or luminosity, especially of those sources of light that cannot be brought into the laboratory, such, for example, as the heavenly bodies. The fact that the increase in darkness of the deposit is not simply proportional to the increase in brightness of the light (with equal exposure time) is easily overcome by impressing a light-scale on the plate so that this shall be subjected to whatever treatment, as in development, &c., that the other exposed parts receive. A light-scale is nothing more that a series of small patches that have been exposed to a uniform light for different times, generally so that the amount of light impinging on the respective patches is proportional to the simple series, 1, 2, 4, 8, 16, &c. By measuring the opacities of these patches and plotting them against the amounts of light, a curve can be drawn that will show at once the relationship between opacity and light in that particular case. Since writing this, a suggestion has actually been published to determine luminosity by estimating by chemical means the metallic silver produced on a photographic plate by the agency of the lights that it is desired to compare.

Thus far all is easy, and it is at this stage that the thoughtless worker too often leaves off, considering that he has completed his task. It is easy to teach students to measure and to weigh, nothing of its sort is more easy, but the difficulty begins with the consideration of what it is that has been measured or weighed. The student of chemistry weighs things and gives them names, but the things he weighs rarely are what he calls them, and in some cases I have known the material weighed not to contain a vestige of the substance that it was supposed to consist of. And so it is in other work, the whole difficulty is to know what it is that has been dealt with. In investigational work, there is a strong temptation to move along the line of least resistance, and this distinctly is to perfect the methods of measurement. It is only necessary to get a little knowledge and a good instrument maker, to reduce the differences between the results of the repeated measurements of the same thing. But if the thing measured is not what we take it to be, if there is, for example, 10 per cent. of uncertainty here, it is mere deception and waste of time to seek to reduce the 1 per cent. of uncertainty in the method of measurement. I am convinced that in a vast number of cases of very many kinds instrumental perfection is already far beyond what we can do justice to, and that the pressing difficulties are the avoidance of loss, and the more perfect isolation and more truthful recognition of the thing that is measured.

In the example quoted above in response to the suggestion to use a photographic method for comparing light intensities, it is not the brightness of the lights that would be compared, nor is it their activism, nor their radiant energy. It would be nothing whatever more than a certain effect that they could produce upon a certain sensitive surface. If the sensitive surface were varied the results would be different. The old idea that activism could be equally well measured by any chemical change that light can produce, and that the selection of the sensitive substance is a mere matter of convenience, cannot, of course, be maintained, and so far as it remains of use is a testimony to the clumsiness and the want of discrimination of the methods that we employ.

Brightness is essentially a matter of sight, and the eye is therefore the only standard instrument for its measurement. By putting over a sensitive plate a coloured medium so exactly prepared that a continuous spectrum photographed through it on the plate would give a density of deposit truly proportional to the brightness of the spectrum in all its various parts, a combination would be obtained that would give proportional brightnesses if used in the manner already described.

Time Development as Affected by Temperature.—In the March number I made some remarks on the mechanical method of development employed by some, in which the exposed plates are allowed to remain in the developer for a fixed and predetermined time instead of allowing one's judgment to decide when the image is sufficiently dense. I there pointed out what I believe to be the advantages of such "time development." In the March number of the Journal of the Royal Photographic Society is published a paper by Messrs. Ferguson and Howard, in which they suggest that plate makers should give with their plates the times necessary for development at various temperatures with the formula they recommend. For a given pyro. soda formula, which, by the way, has too little sodium sulphite to secure a deposit free from the oxidised products of the pyro., they find that "kodoids" give the same steepness of gradation at 17° C in 6 minutes, as at at 12° C in 7 minutes 25 seconds, or at 7° C in 9 minutes 50 seconds. They describe in detail a method of determining the relationship between time and temperature when the contrast (or "development factor") remains constant.

If makers of plates do this, and photographers, one and all, do as the makers tell them, then photography as an art may gain something in the ways I indicated two months ago, but it will lose an incalculable range of possibilities in the hands of the skilful. It is one thing to use mechanical methods when the balance of advantage appears to be in favour of them, but quite another to seek to supplant all discretion by rigid rules. The case may be compared to the feeding of convicts who have their food weighed out to them, and the work expected of them definitely catalogued. There is much advantage in this exact balancing of work and food; gluttony and starvation are avoided and economy is secured. But we who are not convicts do not weigh our food nor measure our work, and think that on the whole we have reason for believing that our health is rather better for the discretion that we prefer to exercise. We consider that our experience is worth something.

Iron Lightning Conductors.

Sir Oliver Lodge is reported to have expressed his opinion in favour of iron lightning conductors in preference to copper ones. The former allow the current to flow more gradually and to leak more slowly, while with copper, especially if it be of large diameter, a more sudden effect is produced, which may cause side flashes and do damage. The iron rod may be fused, but only after it has done its work, and it is easily renewed. A lightning conductor should be looked upon as a safety fuse, to be replaced when it has been struck.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Fibrous Constituents of Paper.

(*Concluded from Page* 93.)

Esparto fibres are generally finer and much shorter than those of straw. They are smooth and cylindrical, and free from knots. The walls are thick, and the central canal accordingly very small and uniform. The ends of the fibres are generally rounded. The serrated epidermal cells found in straw are also found in esparto, and can scarcely be distinguished from these, but the large, thin-walled parenchyma cells are absent. The esparto leaf, however, bears on its inner surface a number of little hairs or teeth, some of which are nearly always found in papers made from esparto, and which are quite a trustworthy characteristic.

Chemical wood-pulp shows flat, ribbon-like fibres, not unlike cotton, and even at times twisted like the latter, but with unbroken ends. It would take up too much space were I to endeavour to discriminate between the various kinds of wood, such as pine, birch, poplar, etc., but they all show distinct woody characteristics. The pits in pine wood are quite unmistakable, as are the obliquely-placed slit-like pores of birch and poplar.

Mechanical wood has a strongly-marked woody appearance, but the fibres are not properly separated, and the fragmented nature of the material, due to the way the fibres have been torn and wrenched across instead of separated, is quite unmistakable.

It only remains to add that fibres stained with chlor-zinc iodine are, unfortunately, not permanent. Permanent preparations can be stained with benzo-brown with a trace of soda to deepen the colour, washed slightly, and then stained with benzo-azurin without soda, and gently warmed, and will form beautiful and instructive mounts, though the differentiation will not be that of chlor-zinc iodine.

The mounting medium may be water or glycerine and water, but for permanent mounts glycerine is not convenient to use owing to the fact that it will not harden or dry. To get over this difficulty, glycerine jelly may be used with advantage, the fibres being first carefully soaked in water from which the air has been expelled by previous boiling. Even then there is often much trouble with minute air bubbles entangled in the fibres. I have found it quite satisfactory to proceed as follows: The fibres, whether stained or not, after soaking in boiled water, are arranged in the centre of the slide, which is placed upon a brass mounting table. Sufficient glycerine jelly is then added, and, after melting, the cover-glass is placed in position and held lightly in place with the point of a dissecting needle. The glycerine jelly is now heated until it just begins to boil, when the lamp is quickly removed. This disentangles and carries away from beneath the cover glass any air bubbles. After the glycerine jelly has set it should be cleaned up by dipping the slide in water and wiping it carefully with a rag, and then the cover-glass is surrounded with two coats of gold size. Farrant's solution is also useful, as it is a glycerine mounting medium which hardens at the edges. Canada Balsam is less suitable than glycerine media for mounting fibres. They may also be mounted in water with a little added carbolic acid, enclosed in a thin cell of gold size.

High-power Microscopy.

Mr. J. W. Gordon, F.R.M.S., who has contributed several interesting papers on Microscopical Optics to the Royal Microscopical Society, which have, however, led to some controversy, recently gave an address at the Royal Institution, in which many of his views were summarized in a more popular way and without the mathematical arguments which are necessary to an adequate discussion of such a subject. A résumé will doubtless interest many of the readers of "Knowledge & Scientific News." Mr. Gordon observed that in the exhibition of a microscopic object under high magnifying power there are three stages in which difficulties have to be met and surmounted—(1) In the preparation of the object for exhibition under suitable conditions of illumination; (2) in the representation of the object by means of an image; (3) in the transmission of the image so found in the instrument to the eye of the observer. Professor Wright classified the preparation of objects into colour pictures by means of stains and outline pictures. The method of staining having manifest limitations, Mr. Gordon proceeded to refer to the use of cross-lighting or "dark-ground illumination" in order to show outlines, with especial reference to Dr. Siedentopf's application of this principle to the exhibition of so-called "ultra-microscopical particles." In ruby glass, for instance, the colour is due to minute particles of gold diffused through the glass, so small as to be beyond the powers of the microscope as ordinarily used. By special methods of illumination, however, at right angles with the optical axis of the microscope, and by limiting the plane of such illumination, the particles come into view as diffraction discs. Mr. Gordon then dealt with some experiments of his own, originally suggested by a paper of Lord Rayleigh's, but which were still incomplete, which consisted especially of a method of lighting up the object by means of diffracted light, the principle being explained by a diffraction slit formed by the edges of two knives stuck in a board so that their edges overlapped towards the points, but were about an eighth of an inch apart near the handles. It was with such a piece of apparatus that Sir Isaac Newton worked when he made his first precise recorded observations on the subject of diffracted light. Mr. Gordon referred to the observation of Helmholtz, as far back as 1874, that the limit of useful power in a high-power objective is reached when the lens of the objective is of such focal length that its diameter is rather less than the diameter of the pupil of the eye, and that beyond that point there was no advantage in increasing the magnifying power of the objective, but that further magnification was best obtained by increasing the power of the eyepiece. But this method had also drawbacks owing to the smallness of the emergent pencil of light; such, for instance, as the greater prominence of dust upon the lens or of floating particles in the eye. Mr. Gordon considered that this was responsible for the limitation of magnifying powers at present in use by microscopists to 1500 or 2000 diameters, whilst most good work was done

with magnifications of from 400 to 600—a statement, however, which surely needs some qualification, whatever may be the incidental disadvantages due to high eyepiecing. However, Mr. Gordon's method of getting over the difficulty is by the interposition in the tube of the microscope of a ground-glass screen on which the image is received from the objective, so as to scatter the incident rays of light, the screen being made to oscillate in order to prevent its grain from becoming visible, and so impairing the details of the picture. This picture can then be magnified again by means of a second microscope in place of an ordinary eyepiece, with consequent greatly increased magnification. It may not perhaps be superfluous to remind my readers that the mere magnification of an object, or even the rendering visible of what could not otherwise be seen to be existent, as under Siedentopf's experiment, does not give any optical solution as to its true shape and size. In fact, it has been mathematically proved, and remains true, to quote Lord Rayleigh's own words, "In the microscope there is nothing except lack of light to hinder the visibility of an object however small. But if its dimensions be much less than half a wave-length, it can only be seen as a whole, and its parts cannot be distinctly separated, although in cases near the border-line some inference may possibly be founded upon experience of what appearances are presented in various cases. . . . What has been said about a luminous point applies equally to a luminous *line*. If bright enough it will be visible, however narrow; but if the real width be much less than the half wave-length, the apparent width will be illusory."

Royal Microscopical Society.

March 15th, at 20, Hanover Square, Mr. A. D. Michael, F.L.S., in the chair. Mr. J. E. Stead delivered the second part of his lecture on micro-metallurgy, entitled "A review of the work done by metallographers," illustrated by lantern slides supplied by prominent authorities in several countries. Over 120 slides were shown on the screen by means of the epidiascope, and were accompanied by explanations and comments by the lecturer. The series commenced with the earliest work of Dr. Sorby, followed by illustrations of the microscopic characters of iron and steel, silver, lead, copper, tin, and antimony. Illustrations were also shown of the changes produced in metals by strains, a diagram of the apparatus by which rapid reversals of strains were effected being exhibited in illustration of this portion of the subject. The effect of continued heating of an alloy of copper and tin in boiling mercury and also that produced by immersion in liquid air were demonstrated. Slides were also shown to illustrate "surface flow" in antimony, and the microscopic structure of the new silver standard. The following were elected as Honorary Fellows of the Society: Prof. Wm. Gilson Farlow, Prof. Herbert S. Jennings, Prof. Edmund B. Wilson, and Prof. R. W. Wood.

Notes and Queries.

Bausch and Lamb's New Catalogue.

Messrs. A. E. Staley and Co., of 19, Thavies Inn, Holborn Circus, E.C., have sent me the new illustrated catalogue and revised price list of the Bausch and Lamb Optical Company, of Rochester, New York. The illustrations, most beautifully reproduced, make the catalogue quite a work of art. I understand that it will be sent to any applicant on receipt of three stamps to cover postage.

Miss Frances Elliott (*Staines*).—Crystals of lead nitrate would be best shown by polarized light. Asbestos can be shown by reflected light with a low power; geological slides should generally be thin enough to be shown by transmitted light. A binocular would exhibit all these very well. I should strongly recommend you to lose no time in beginning to make your own slides—until you do this you can scarcely consider yourself as having started microscopical work, and you will not only find the work most interesting, but will feel your interest deepened in many ways. In the meantime dissect as much as you can, so as to find out for yourself all you possibly can about the object you are studying, and read it up at the same time. It is of the utmost importance to get an interest in some definite line of study, and to endeavour to master the subject. Pond life is most fascinating and teaches one many things both in zoology and botany, and the present is a very good time to begin. Ready prepared slides have, of course, an undoubted educational interest, but they are not to be compared in this respect with work done by oneself, especially if it is the outcome of a definite aim.

Alfred Goldsbury (*Maxwelltown, N.Z.*).—It is quite common to find parasites in insects such as you describe, but the information you give does not allow me to say more. The ova also are in quite the usual place. If you want any further information please send the slides themselves—they will be duly returned if you wish it.

A. H. Glaister (*Darlington*).—A 1-12 inch immersion of N.A. 1·25, such as you possess, will readily resolve *Amphipleura pellucida*, and the Watson universal condenser is quite suitable, but there is no advantage in using the latter in oil contact as its aperture does not exceed 1·0 N.A. You say, however, that your objective is corrected for the short tube, and it must therefore be used with the short tube only. I think if you carefully carry out the instructions I gave in "Knowledge" for November last (page 279), you should have no difficulty in resolving the diatom by means of oblique light, especially if it is mounted in a medium of so high a refractive index as realgar. The resolution by means of axial illumination is less easy; it is best shown by carefully focussing the edge of the lamp flame with the condenser and then slightly racking the condenser up within its focus. Are you sure that your objective is clean and free from oil on the front lens behind as well as in front? Human blood corpuscles may be classified as follows: Red corpuscles, which appear yellow when looked at singly, and white corpuscles. The red corpuscles are circular discs, thicker at the sides than in the centre, about 7·5 μ wide and 1·6 μ thick (μ = ·001 millimetre) and without nuclei. The white corpuscles are much less numerous (about 1 in 500). They are nucleated and are classified according to the shape of this nucleus and their affinity for certain stains, but they vary somewhat. They are known as leucocytes, and those which take up foreign particles are phagocyctes. Those which stain with basic dyes such as methylene blue are known as basophil, whilst those which stain with acid dyes such as eosin are termed eosinophil. A very general classification of the white corpuscles is polymorphous, with lobed, or multipartite nuclei; lymphocytes, with large nucleus and little protoplasm; hyaline, with somewhat similar nucleus, but more surrounding protoplasm; eosinophil, with large granules staining deeply with eosin; and basophil, staining with methylene blue.

E. G. W. (*Hull*).—Many objects, especially botanical subjects, can be cut quite satisfactorily by hand. The object is held between the finger and thumb, the index finger being curved round the tip of the thumb and held horizontally so as to form a support for the razor. The object may be held in a piece of pith or even cork. Inexpensive hand microtomes can be purchased from any of the instrument makers if necessary, and in these the object is wedged with pith or cork, or in a piece of carrot. The knife should be drawn steadily from heel to toe with a drawing or slicing movement, the cut being towards one. It should be dipped frequently in water or spirit and water, and effort should be made to cut thin sections rather than complete ones. Most objects cut much better if previously hardened in methylated spirit.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for May.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.36, and sets at 7.20; on the 31st he rises at 3.52, and sets at 8.3.

Sunspots and faculæ may be observed on the solar disc on any clear day, whilst spectroscopic observations usually show conspicuous prominences on the limb. For locating the positions of spots, &c., with respect to the Sun's axis, the required data is as follows:—

Date.	Axis inclined from N. point.	Equator N. of Centre of disc.
May 1 ..	24° 18′ W.	4° 3′
,, 11 ..	22° 8′ W.	2° 59′
,, 21 ..	19° 21′ W.	1° 50′
,, 31 ..	15° 56′ W.	0° 39′

THE MOON:—

Date.	Phases.	H. M.
May 4 ..	● New Moon	3 50 p.m.
,, 12 ..	☽ First Quarter	6 46 a.m.
,, 18 ..	○ Full Moon	9 36 p.m.
,, 26 ..	☾ Last Quarter	2 50 a.m.

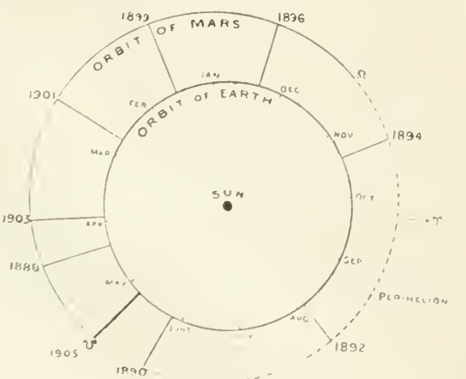
OCCULTATIONS.—The following occultations of the brighter stars are visible at Greenwich:

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance Mean Time.	Angle from N. point.	Angle from Vertex.	Moon's Age.
			p.m.			p.m.			d. h.
May 6..	α Tauri ..	1·1	5.28	63	24	6.30	287	246	2 2
,, 12..	A Leonis .	4·6	8.46	124	99	9.53	279	245	8 5
,, 13..	e Leonis ..	5·1	7.26	136	137	8.34	272	258	9 3
,, 15..	38 Virginis ..	6·2	8.30	191	200	8.48	220	226	11 4
						a.m.			
15..	k Virginis ..	5·9	11.30	76	54	0.24	329	300	11 8

THE PLANETS.—Mercury is a morning star in Aries, and is at greatest westerly elongation of 25° 26′ on the 21st, when he rises at 3.26 a.m.

Venus is also a morning star in Aries, rising about 3 a.m. near the middle of the month.

Mars is a conspicuous object in the evening sky, looking S.E. and rather low down. The planet is now at a favourable point for observation, as he is in opposition to the Sun on the 8th.



Opposition of Mars 1905

The present opposition is more favourable than that of 1903, in that we approach nearer the planet by some 9 millions of miles, the apparent diameter of the planet now being 17"·2, as compared with 14"·6 in 1903. The position of the planet in the sky, however, is more unfavourable for these latitudes, since the meridian altitude is 17° lower than at the last opposition. As will be seen from the appended diagram, the present opposition is not the most favourable since the distance of the planet from the Earth is 50 millions of miles, whilst under the best conditions the distance is only 35 million miles.

The latitude of the centre of the planet's disc is + 15°. Thus the northern hemisphere is presented to us. The season on Mars corresponds to our August. On the 1st the planet rises at 8.3 p.m. and on the 31st at 5.15 p.m.

It is interesting to note that the Earth and Moon as seen from Mars will appear to transit across the Sun's disc on May 8, since the planet happens to be near the descending node. The last two transits occurred in 1879 and 1800 at the other node. The next will be in 1984.

According to Mr. Crommelin the diagram below represents the transit of the Earth and Moon as seen from Mars, across the Solar disc.

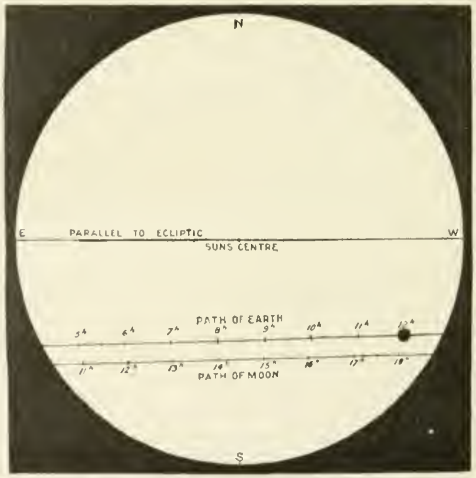


Diagram showing Transit of Earth and Moon as seen from Mars, May 8.

The beginning and end of the Earth's transit across the Sun's disc will be 4.10 p.m. on the 8th and 0.52 a.m. on the 9th respectively, hence owing to the absolute symmetry of the illumination of the planet between these times, it will be a favourable opportunity for measuring the diameter and polar compression of Mars.

Jupiter is invisible, being in conjunction with the Sun on the 4th.

Saturn is a morning star in Aquarius, rising about 2 a.m. near the middle of the month.

Uranus is situated in Sagittarius, and rises about 11 p.m. on the 15th.

Neptune appears in proximity to the star μ Geminorum, but it is now getting well to the west, and sets about 11 p.m. near the middle of the month.

METEORS.—The principal shower during May is the *Aquarids*. This may be looked for between May 1-6; the radiant being in R.A. 22 h. 32 m. Dec. S. 2°., near the star Aquarii.

Knowledge & Scientific News

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Thorp Gratings and Small Cameras in Eclipse Work.

By WILLIAM J. S. LOCKYER, M.A., PH.D.

THE total solar eclipse of August next will, no doubt, attract a large number of people away from these shores, and possibly the great majority will go armed with a kodak or some other form of small camera, in order to bring back a record of the corona.

It is unfortunately generally considered that the work accomplished with small cameras, that is, those having an aperture of about one inch, has no scientific value, because the employment of larger instruments by the numerous official parties gives all the information that is desired, and in a more efficient manner.

During the last few eclipses the small camera has demonstrated that it is capable of obtaining results which cannot be secured with instruments of large dimensions. Perhaps the first most notable instance of this is the success that was achieved in the photography of the coronal streamers. Thus, in the Indian eclipse of 1898, with lenses of $1\frac{1}{2}$ inches in diameter, and 9 inches focal length, Mrs. Maunder obtained a photograph of the corona, showing one streamer extending to a distance of 12.9 lunar radii from the moon's limb. At the same eclipse, a blue-jacket made exposures with the writer's camera (lens aperture 0.8 inches, focal length 8.8 inches) fixed on a stand, and, with an exposure of 15 seconds, obtained a picture showing one streamer extending to 10 lunar radii from the moon's limb.

A reproduction of this photograph is here shown (Fig. 1), but unfortunately the extensions are too delicate to be satisfactorily indicated.

The special object of the present article is, however, to draw the attention of those who will employ small cameras to the use of Thorp's replicas of Rowland gratings in connection with them. Not only can a picture of the corona be obtained, but *at the same time*, and *on the same plate*, the spectrum of the corona is also secured. This spectrum is in the form of rings, like that obtained with the prismatic cameras.

It may be said that the spectrum of the corona is obtained best with apparatus of large dimensions. This is true if the spectrum of the chromosphere be inferred, but in the case of the coronal rings, which are faint (with perhaps the exception of the green ring), there seems a great chance of small cameras rendering valuable assistance.

The main objects then of using these small instruments fitted with these gratings are to give us (*a*) long coronal streamers (if there be any), and (*b*) a record of the coronal rings. With this aim it is therefore best to be well within the shadow, as near to the central

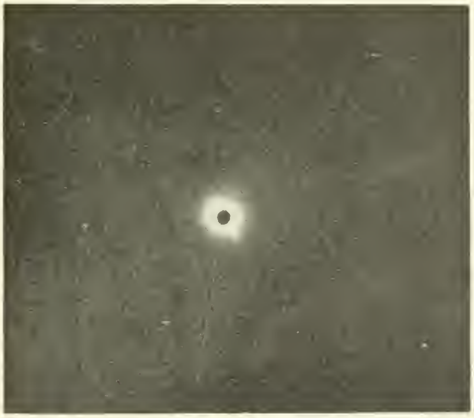


Fig. 1.—The Corona of the Eclipse of 1898 as photographed with a Zeiss lens of 0·8 inches aperture and 8·8 inches focal length. The planet Venus is seen in the right-hand bottom corner.

line as possible, and to commence the exposures some seconds after totality has begun, and finish the last exposure some five or ten seconds before the end of totality. This course is suggested to eliminate as far as possible the chances of photographing the chromospheric spectum, which might mask the coronal rings.

At the present time Thorp gratings can be procured in two sizes, the ruled surfaces covering an area of $1\frac{15}{16}$ by $1\frac{3}{8}$ and $\frac{15}{16}$ by $\frac{13}{16}$ inches respectively. The former are mounted on selected or worked glass $2\frac{1}{2}$ by 2 by $\frac{3}{16}$ inches in size, while the latter are placed on glass plates 2 by $1\frac{5}{8}$ by $\frac{3}{16}$ inches. The prices vary from fifteen shillings each to ten and even lower.

The grating should be fixed square on to the front of the camera lens with the lines of the grating in a

vertical plane. This is accomplished by making a small wooden frame, on the insides of which grooves are cut for the insertion of the grating. At the back of this frame a circular adapter is fixed so that the frame can be placed tightly on to the hood of the lens. It is advisable to make the frame and circular adapter as close fitting as possible, and to place the grating-side of the glass towards the lens, because the front lens should be as near to the grating as possible. A great advantage of the latter instruction is that the grating surface is protected from damage.

Such an adapter as above described is shown in the accompanying illustration. (Fig. 2). This shows a grating attached to a 5 by 4 Kodak, and experience has proved that the arrangement serves all practical purposes.

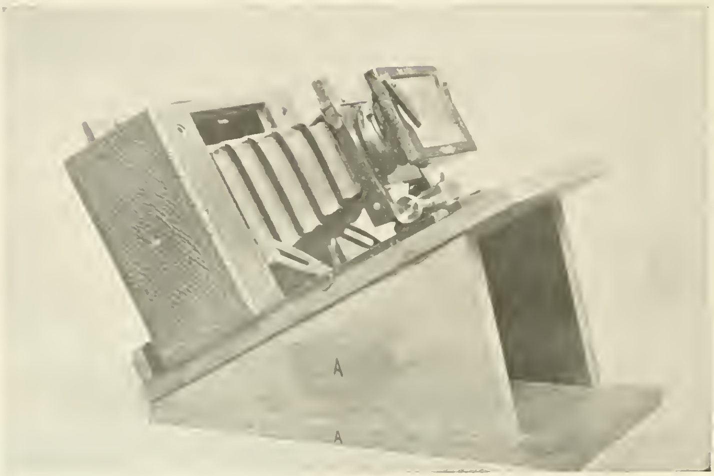


Fig. 2. The grating attached to a 5 by 4 Kodak Camera.

Those who possess more lenses than cameras can easily make a box-form of camera, the focussing being done either by moving the lens or by mounting the dark slide in a framework which moves in and out of the box. The accompanying figure (Fig. 3) illustrates a home-made camera, which has already done yeoman service on many occasions.

A camera fitted with a grating in the way above described when turned directly towards the sun shows an image of the sun in the centre of the ground glass, and a spectrum on each side of this image; these are the first order spectra given by the grating. Further away from the direct image still, and again on each side of it, will be found another spectrum, fainter, but

Fig. 3.—A rough home-made Camera with grating attached.

Fig. 4.—A perspective view of a box Camera, arranged to photograph the image of the Corona and the first and second order Spectra.

of greater length than the first; these are the second order spectra.

It may happen that the two spectra of the *first* order cannot both be made to fall on the ground glass, because the plate is not sufficiently large. In this case no attempt should be made to photograph both spectra; but the solar image should be moved a little to one side of the centre, and one of the spectra made to appear on the plate.

To take fuller advantage of the grating, especially on such an occasion as an eclipse of the sun, more enterprising observers can easily construct a special form of box camera. By this means both the corona and the first and second order spectra can be secured.

Such a camera as this is shown in the accompanying illustrations (Figs. 4 and 5), and was used with successful results in the Spanish eclipse of 1900. Even the form here given did not take the fullest advantage of the grating, because it was arranged only to photograph the direct image of the corona, and the two orders *on one side* of this image.

In the figures it will be noticed that the camera is constructed flat, the lines radiating from the lens (shown on the top of the box) indicating the directions of the incident light falling on the photographic plate. The thicker line on the right (Fig. 5) represents a diaphragm to cut off the reflections from the side of the box of the first and second order spectra that were not required. The focussing of the camera was accomplished by making the lens capable of being moved in and out of the box. It may be remarked that the grating in front of the lens makes no difference to the ordinary focal length of the lens, so that cameras which are focussed according to distance require simply to be set for infinity, as if an ordinary landscape was being taken.

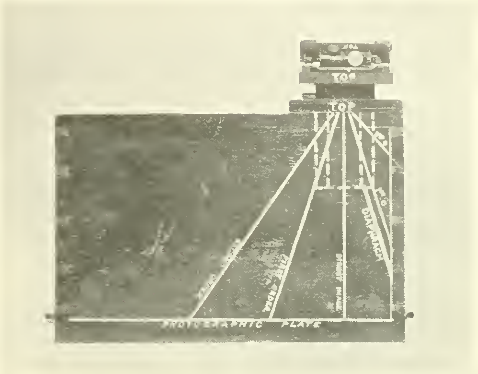


Fig. 5.—The same Camera as illustrated in Fig. 4, but seen from above. The white lines indicate the directions of the images of the Corona and the Spectra.

Fig. 6.—The Corona and first order Spectrum as photographed with the Camera shown in Figs. 4 and 5. Enlarged twice. Exposure 65 seconds.

Fig. 6 will, perhaps, give the reader some idea of the nature of the picture he will secure, but in this case only the first order spectrum has been reproduced. Owing to the fact that the solar light was thrown on to the grating by means of a siderostat, it was possible to give a long exposure to the eclipsed sun; for this example the exposure lasted 65 seconds.

Unfortunately, the plate was begun to be exposed before the chromosphere was covered by the moon, so that the spectrum in this instance is chiefly chromospheric. Nevertheless, the green ring forms a very conspicuous feature in the original negative.

In cases in which the camera is not equatorially mounted or used in connection with a siderostat, heliostat or coelostat, the exposures have to be restricted to about 20 seconds, otherwise the apparent movement of the sun would cause the image to change its position on the photographic plate and so spoil the result. For such exposures, therefore, very fast plates should be used, and the spectrum plate is one to be recommended.

It is hoped that by employing gratings in this manner a new interest will be given to the user of small cameras, and that they will be rewarded with results that may prove of service to the cause of Solar Physics.

The Action of Wood on Photographic Plates in the Dark.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

Some years ago Mr. T. C. Hepworth informed the writer that he had taken away some plates wrapped in dark paper in a wooden box, and that to his surprise many of them were "fogged" when unpacked a few days later. The phenomenon appeared inexplicable until in 1897 Dr. W. J. Russell showed that turpentine vapour had a pronounced darkening action upon a photographic plate, and in 1899 contributed a paper to the Royal Society in which it was shown that many other hydro-carbons, such as resins, had the same

property. The reduction of the silver was also found to be effected by vegetable substances with a strong odour, such as coffee, brandy, and linseed oil, which contain compounds, terpenes, allied to turpentine.

Dr. Russell attributed the phenomenon to the action of hydrogen peroxide formed by the oxidation of these terpenes in the presence of water (see "KNOWLEDGE AND SCIENTIFIC NEWS," this vol., p. 100).

Dr. Sperber, however, held a different theory and concluded from the results of a simple experiment that the action of the turpentine was due to photo-chemically active radiations. He found that when three plates were placed horizontally on a skeleton stand under a bell-jar with the bottom and middle plate film uppermost and the top plate film downwards, while a dish of turpentine was placed on the middle plate, all the films were completely blackened after four days. The experiment was now repeated with the position of the films reversed, so that the top plate was film upwards and the other two film downwards. In this case only the edges of the films were darkened, although the jar was equally full of turpentine vapour, and there would thus be the same possibility of chemical reduction. According to the radiation theory, only the edges of the plates in the second experiment would receive reflected rays from the wall of the bell-jar, whereas in the first experiment the rays would strike directly on the upper film and be reflected directly on to the lower films.

Last year Dr. von Aubel showed that various resinous substances could affect a photographic plate through black paper, but that the property was lost on heating the substance above its melting point.

Prior to this, experiments had been made by Mr. Hepworth and the writer to determine whether the "fogging" phenomenon mentioned above might not be due to the presence of resinous constituents of the wood, and it was found that many different kinds of wood possessed the property of so affecting a photographic plate in the dark that when developed in the usual manner a good impression of the section of wood was obtained.

Later in the year Dr. Russell communicated to the Royal Society the results of his very complete experiments on the same lines. He found that the impression was formed in 30 minutes to 18 hours, and that different kinds of wood showed great differences in their behaviour. Thus conifer woods were particularly active, as was also the case with oak, beech, Spanish chestnut, sycamore, and rosewood, while elm, ash, horse chestnut, and plane had but little action on the plate. But these relatively inactive woods could be rendered active by exposing them beforehand to sunlight or to blue rays, and this treatment also rendered the active woods still more active. Larch gave interesting pictures, the dark rings of the wood being active and the light rings inactive, while the reverse was the case with Scotch fir. The true bark of a tree and also the pith were found to be entirely inactive, but very old wood and bog wood had retained their activity.

In the present writer's experience very dry wood is less active than that which has been in a moist atmosphere. The effect produced by a piece of old very dry oak is shown in the accompanying figure. The piece of wood was left for several days on a Barnet medium plate enclosed in a well-fitting cardboard box in the dark room. As it had apparently had no effect, the experiment was repeated, and the plate developed after a year.

The print is interesting as showing certain features not seen in the beautiful pictures obtained by Dr. Russell. There is a curious halation round the edges of the wood which seems to indicate that the cross section of the grain is more active than the longitudinal section. It also shows that wood that is apparently inactive may give an impression if left for a very long period.

April, 1904, to April, 1905.
Oak left in contact with Photographic Plate in the dark for a year.

Herr G. Lunn has recently shown that a strawboard box is radio-active, the rays apparently proceeding from a number of points over the surface so that they form an irregular outline of an object placed upon a photographic plate in the box. The board becomes spent after an experiment, but recovers spontaneously if left to itself.

Here, again, it is probable that resinous substances are the active bodies, but further experiments are required to determine whether hydrogen peroxide is formed and plays the part of an intermediate agent in any of these phenomena.

A Bird-like Flying Machine.

By F. W. H. HUTCHINSON, M.A., B.CH. (CANTAB.).

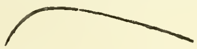
(A Paper read before the Cambridge University Engineering Society.)

To those who have not given attention to the structure of a bird's wing, the following rough description may be of interest. The wing of a bird may be regarded as having two portions. (1) That part to the outer side of the wrist joint. The main feathers of this portion are usually about 10 in number and are known as the primary feathers. (2) That part to the inner side of the wrist joint which may be called the body of the wing. The main feathers of this portion vary according to the length of wing.

(*a.*) A salient characteristic of a bird's wing as a whole is the comparatively rigid and heavy anterior edge, and the light, yielding, elastic posterior margin.

(*b.*) If the primary feathers be examined carefully it will be seen that each one differs from its fellows, and that they differ in a graduated series. The quill is curved, and the feathered portion or penna is set round this in a helicoidal curve. Here, again, the portion anterior to the quill is stiff compared to the portion behind it.

(*c.*) Another characteristic of a bird's wing is that a fore and aft vertical section through the body of the wing discloses a curve somewhat of this shape.



This curve is more pronounced about mid-way between the wrist and the shoulder joint, *i.e.*, in the region of the elbow. When the wing is in the extended position for flight, this joint is distinctly behind the front edge of the wing. (Mr. Hargrave, of New South Wales, has devoted study to this curved portion, and it may, perhaps, be convenient to describe the curve as the Hargrave curve.)

Mr. E. P. Frost, of West Wratting, a well-known member of the Council of the Aëronautical Society of Great Britain, as a result of careful observation of the structure of natural wings of all kinds, and of the movements of wings in flight, came to the conclusion more than 20 years ago that for ordinary flight a wing is merely beaten up and down.

It is obvious that, owing to the yielding elastic posterior edge of a bird's wing, on the wing being beaten downwards both a lift and a drive is obtained.

It is also obvious that on the wing being elevated, a forward and downward resistance is evoked. (But the wing is so shaped that the down stroke must encounter greater air resistance than the up stroke, apart from considerations of the amount of energy put into the up and into the down stroke. Also the arrangement of the wing feathers causes a valvular action. Air passes through the body of the wing on the up stroke.)

Mr. Frost has contended that the result of the arrangement of the primaries must be that on being struck downward in the air, their ends travel forwards and upwards. In flight the wing tips of a bird (*e.g.*, a rook) can be seen to be curved upwards. If a shed primary feather be taken and held in its natural orientation and struck smartly down in the air the tip can be seen to spring markedly forward. Then the posterior edge of the penna becomes tense. But when the feather is not so stressed the posterior edge is sinuous and has a fullness. Other (normal) movements have been described, notably the so-called "figure of eight" curve generated by the movements of the wing tips; but Mr. Frost has contended that the movements of the wing tips in what may be considered normal steady flight are the automatic results of the peculiar construction of the wing and of its being beaten up and down against the air.

If during the down stroke the primary feathers are strained forward and upward within their elastic limits, it is obvious that energy is stored in them; and its restoration may in part occur even on the up stroke.

The curve (Fig. A) is taken from Marey's "Le vol des oiseaux," and the following description extracted from the text. It was photographically obtained, and shows the movements of a piece of white paper fixed to the tip of the first primary of a black crow. The crow was caused to fly in front of a dark screen, and the lens exposed during five beats of the wings. The curve shows only the trajectory of the white paper; and Marey directs attention to the increase of distance between successive loops due to the increasing mean velocity of the bird.

The recurving at the bottom of the loops would seem

Direction of Flight. <——

Fig. B.—Trajectory of Bird's Wing.

to be due to the restoration of energy from the forward stressed feather. (The portion which the present writer ventures to indicate between the lines k and k[1] seems to be from just before the commencement of the down stroke to the commencement of the next.)

The curve (Fig. B) was recently obtained by Major B. Baden-Powell in the following way: Small birds were procured, and tubes of paper were prepared, whose internal diameters were approximately the distance between the tips of the outstretched wings of these birds. The internal surfaces of the tubes were covered with a coating of lampblack. A tube was then arranged with one end in a room and the other end pointing out of doors through an open window, and a bird liberated within the inner end of the tube. As it flew out towards the light a record of the movements of the wing tips was obtained by the tips of the feathers scratching off the lampblack. Several observations were made, a fresh tube being used each time. On page 121 is a reproduction of one of the actual records (reduced in size).

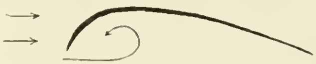
Fig. A.

Major Baden-Powell considers these marks to represent the down stroke, and the light scratchings seem to show that the wing is flexed on the up stroke.

The writer ventures to think that the difference in the distinctness between the two portions is due to the wrist being in a slightly flexed condition on the up stroke in what may be considered the normal position, and that on the down stroke the stressing of the primaries automatically increases the distance between the wing tips and opens the wrist automatically against its elastic re-action. The wing *as a whole* is essentially an elastic structure. The absence of recurvation at the lower portions of the record taken in conjunction with the form of the down stroke record, would seem to show that (being in the tube) the bird was not flapping at full vigour, or quite normally, and that the stored energy of the primaries was given out during the latter part of the down stroke.

During flapping flight the primary feathers automatically exert a clawing swimming action.

In reference to the Hargrave curve, Mr. Hargrave has demonstrated that when air is blown against such a curved surface—thus



—a lift is obtained against the bight of the curve. He arranged little trap-doors opening upwards, which

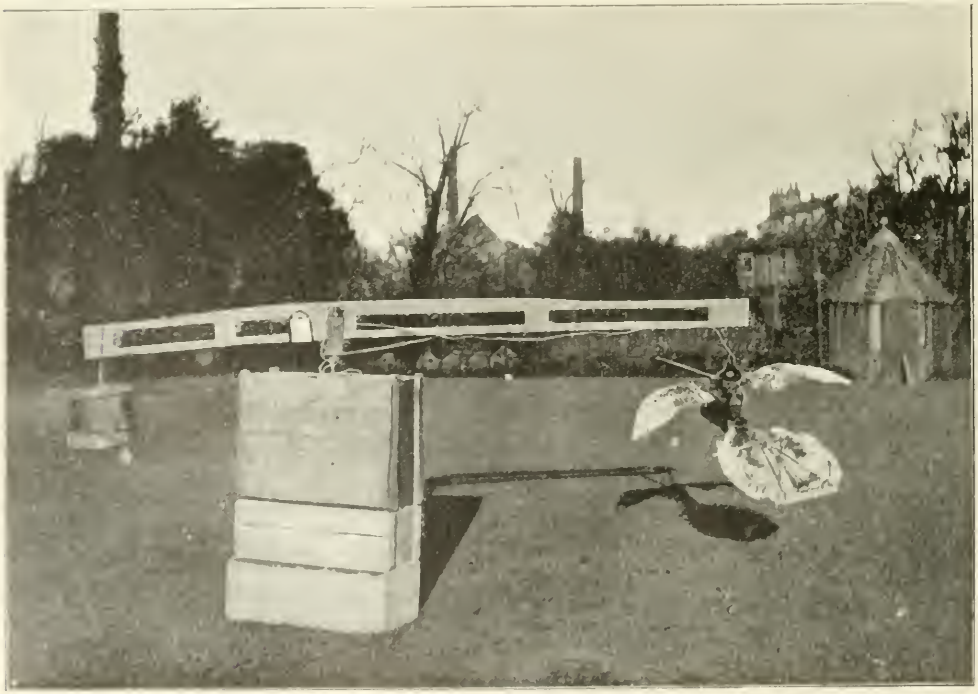


Fig. 1.

opened under the influence of an air current as shown by the arrow.

This is doubtless due to the formation of eddies by the air flowing over the rigid lip.

It is obvious that a bird's wing both as a gliding and a propelling surface is a beautifully efficient instrument.

To test these views, in 1902, Mr. Frost and the writer, with the co-operation of Mr. C. R. D'Esterre, arranged the apparatus shown in Fig. 1. A pair of dried natural wings (area about three square feet) were arranged with a small electric motor and a reduction gear to flap up and down, the arrangement being various authorities as that obtaining with birds, and is not in marked contrast with the ratio obtained (according to published reports) with the large machine of Messrs. Wright in U.S.A.

One may describe a flying lift and a hovering lift.

The hovering lift obtained in a confined space, and only three feet above the floor with the figure 1 apparatus with 1 h.p. gave a lift of 10 lbs.

We considered we had justification for proceeding with a larger model. This has been constructed and partly tested and Figs. 2 and 3 show it on the rough carriage.

It is intended to run this car on a special trough

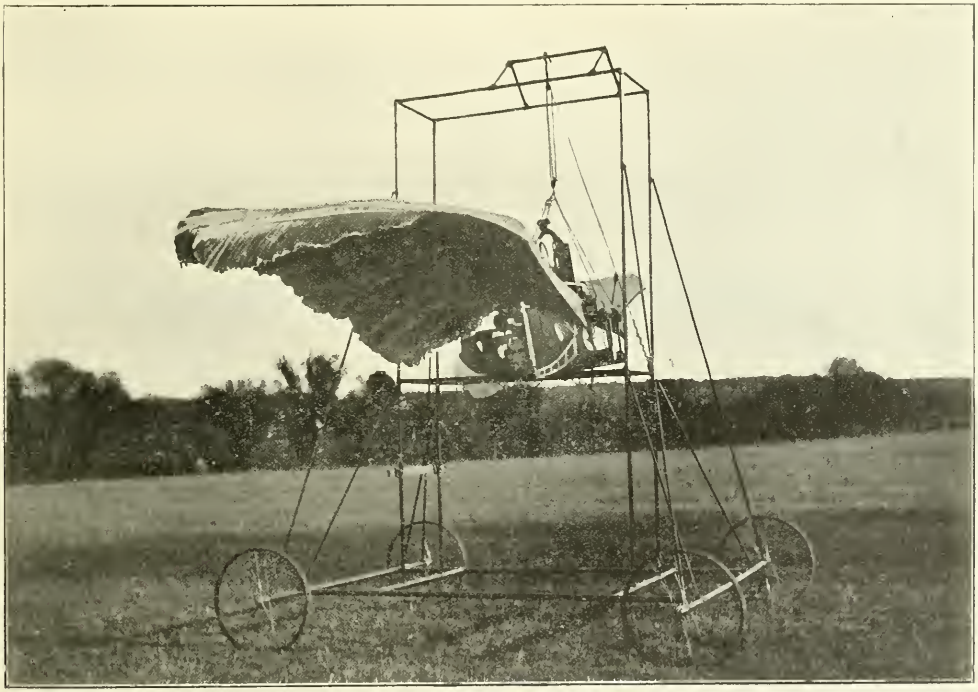


Fig. 2.

suspended by a spring balance from the balanced arm. The best result was obtained as hereunder :—

Volts.	Amps.	Estimated H.P. on Wings.	Estimated loss in Motor and Gear Transmission.	No. of Flaps per minute.	Maximum Lift.
24	12	$\frac{1}{10}$	75%	350 to 400	5 lbs.

The effect was striking. The "bird" flapped itself round and round, although it fell between the down strokes. But against this must be set the fact that its rate of progression was only four or five miles an hour, no doubt owing to air resistance and friction, which were considerable, for the apparatus was crude. Also the "bird" weighed about 21 lbs., which would, of course, pull it down on the up strokes. The oscillations to a marked extent diminished after the tail was fitted.

It will be noted that the ratio of h.p. to lift was 1 h.p. to 50 lbs. This ratio tallies with that given by section track, and to arrange in the frame 4 vertical guides, one at each corner, of stretched cord or wire.

The machine will be suspended from a spring balance. The model has certain crudities in the motive portion, although the workmanship (which, apart from the wings, was carefully carried out by Messrs. Pye, scientific instrument makers, of Cambridge, and the Cambridge Autocar Co., Ltd.) is good. But it is a testing model only, and is merely intended to obtain data from.

The wings are of special construction, designed in accordance with the above enunciated principles. The total wing area is about 20 times that of the No. 1 model (*i.e.*, about 60 square feet). The machine measures about 20 feet across.

The transmission is by coned friction clutch, and chains in two stages, to connecting rod. The crank throw is adjustable for altering the size of angle of

flap. The top sprocket of second motion can be raised or lowered for altering the limiting positions of the wings (*i.e.*, the position of the arc). The lower end of the connecting rod actuates the inner ends of the levers for wagging the wings by a simple device of two oscillating roller-carrying links attached to the cross head, whose pin is constrained by vertical guides.

To the brackets, seen below the wings, are attached "pectoral cords" of elastic. These store up energy on the up stroke, and so obviate too violent alternations of load on the driving mechanism.

The motor is a nominal 3 to 3½ h.p. petrol cycle-engine.

The wings are at present arranged to flap 100 times a minute, which is, of course, considerably less than powerful sweep of the wings. The spring balance reading is here obviously fallacious so far as registering the lift goes, because the rope is pulling the machine back. However, at the rough tests so far made, the balance shows a diminution of reading of 80 and 160 lbs. at the down stroke when the machine springs upwards but also forwards.

At the preliminary trial already made the wings described a diminished angle to that of the No. 1 model.

It should be noted that with this angle and 100 flaps per minute the wings appear capable of evoking a resistance of about 100 lbs. each, and the machine is raised about two feet at each stroke. It is difficult at present to form a correct idea of the position of centre of pressure, but we think that it goes through an arc of

Fig. 3

proportionately corresponding to the increased area and h.p. But increased area does not imply proportionally increased resistance.

The machine has been suspended from a tree bough, and the wings flapped under power. The results are very promising. At each down stroke the whole machine, apart from the carriage, weighing 232 lbs., is lifted up bodily into the air and forwards. It rises about two feet each stroke. It looks just like a gigantic bird trying to fly under similar conditions. At the down strokes the suspending rope leaves the vertical and becomes markedly inclined. The pull on the rope then pulls the machine back, so that even if it be capable of flight it cannot fly under these conditions. At the down stroke it seems that, if the rope were then severed, the machine would travel up and away with the

2.25 feet on the down stroke.

In the model, which is susceptible of considerable lightening, we have nearly 33 square inches per lb.

There are grounds for believing that a feathered wing made of a number of units can exert a greater resistance than a simple wing; such as that of the insect or bat type, or the various simple mechanical wings which have been hitherto used in wing flapping machines. There are experimental grounds for believing that resistance is more dependent on periphery of an aëroplane than on its superficial extent.

Furthermore, the primary feathers must certainly act as a series of stepped aëroplanes, each acting on air from a different level which has *not* had a downward velocity imparted to it by having had to sustain the weight of a previously acting supporting surface.

The Nature of Life.

By Geoffrey Martin, B.Sc. (Lond.).

I.

[This interesting paper, by Mr. Martin, opens up some new conceptions regarding the nature and origin of life.

In the first part the author commences by explaining how all chemical compounds decompose at a certain critical temperature and pressure, and how the number and kind of atoms in the molecule decide the degree of temperature. He then discusses what would be the composition and properties of a substance whose critical temperature and pressure coincide with those now prevailing on the earth's surface, and he comes to the conclusion that living protoplasm possesses in every respect the properties of such a compound. He then develops this idea. Some parts of the protoplasm decompose somewhat more rapidly than other parts, and, corresponding more sensitively to certain influences, thus develop into different organs.

In the second part (to be published next month), it is suggested that since the temperature of the world's surface was in former times very different to that which now prevails, the modern protoplasm is simply the product of evolution of older kinds of protoplasm, living at high temperatures, in which heavier elements, such as silicon, phosphorus, sulphur, &c., replaced the lighter elements which now principally compose it.

In a third part, future developments are discussed.—Ed.]

If we place a given chemical compound (say $CaCO_3$) in a closed cylinder and subject it to a continually increasing temperature, keeping the pressure constant by means of the piston, then at a certain temperature range the compound begins to decompose. If, now, we increase the pressure sufficiently, the decomposition ceases and the substance can now bear a higher temperature than before without decomposing. Proceeding in this way, it is obvious from the finite nature of the mass of the atoms, and from the limited intensity of the forces holding them together in the molecule, that ultimately at some definite temperature the external forces tending to drive the atoms apart will become equal to the maximum internal forces that the atoms *can exert* on each other in the molecule. It is, therefore, obvious that above a certain definite temperature, depending upon the nature of the molecule, *no pressure, however great, can prevent the substance from completely decomposing*. This temperature and pressure, above which a compound is incapable of existing, we will call the *critical temperature and pressure of decomposition* of the compound.

The critical temperature of decomposition would, therefore, be completely analogous to the critical temperature of liquefaction of a compound—only in the latter case we are dealing with the temperature whereat a certain *molecular* condition of existence disappears; and in the former case with the temperature whereat a certain *atomic* condition of existence disappears.

Since atoms are a very much more finely divided form of matter than molecules, it is clear that the critical temperature of decomposition of a compound must be a very much sharper and clear-cut constant than its critical temperature of liquefaction.

The critical temperature and pressure of decomposition of even very unstable compounds is usually very high. For example, although $AuCl_3$ is almost completely decomposed at about 200°, yet Rose's experiments show* that it is capable of existing in traces at very high temperatures indeed. Cyanogen, ozone, and the oxides of nitrogen, although very unstable at ordinary temperatures, seem capable of existing at excessively high temperatures.

In general, the smaller the number of atoms in the molecule of a compound, the higher is its critical temperature of decomposition; whereas the greater the number of atoms, the lower the critical temperature. The reason of this is, of course, due to the general fact that the more atoms there are added on to a molecule, the feebler is the intensity of the forces holding the atoms together in the molecule—as is evident from the general observation that the more complex a compound is, the more easily decomposable it is.

If, now, by some means or other we proceed to steadily add on atoms to a molecule so as to make it more and more complex, we steadily lower its critical temperature of decomposition. And by adding on a suitable number and kind of atoms, we could reduce the critical temperature and pressure of the compound until they *coincided with the normal temperatures and pressures which hold upon the earth's surface.*

Such a compound would be possessed of an extraordinary sensitiveness to external influences on account of the sharpness of the constants called above the critical temperature and pressure of the compound. A slight increase of temperature, or a slight decrease of pressure, would serve to throw it into a condition of rapid chemical decomposition; whereas a slight increase of pressure and decrease of temperature would cause the substance to suddenly cease to decompose; and even did we maintain the external temperature and pressure *exactly* at the critical temperature and pressure of the compound, nevertheless, the external impulses which are continuously pervading all space in the neighbourhood of the solar system, beating intermittently upon the sensitive substance, would alone be sufficient to throw it into a series of rapidly alternating states of decomposition and repose.

In order to generate such a complex compound, we must first take as the central atom an atom capable of exerting a high grade of valence, and possessing a well-developed power of self-combination. The high valency grade of the central atom is necessary in order that we may be able to add on to it atoms of different natures so as to regulate precisely the stability of the resulting compound; and the power of self-combination is advisable in order that the molecule may be of the necessary grade of complexity, so as to reduce its critical temperature and pressure of decomposition exactly to the temperature and pressure which hold upon the earth's surface. The atoms added on to the central atom must possess a small but perceptible affinity for the atom and for themselves.

What known elements, therefore, would be most suitable to enter into the structure of such a compound? A study of the elements will convince the reader that the element of high valency grade which possesses the power of self-combination (and, therefore, the possibility of generating complex compounds) most highly developed is carbon; and the five elements most abundant upon the earth, which possess a small but quite definite mutual affinity for carbon and for themselves, are hydrogen, oxygen, and nitrogen, and in a lesser degree sulphur and phosphorus.

We should expect, therefore, to find such a complex compound to be composed chiefly out of carbon, hydrogen, oxygen, nitrogen, and containing small amounts of sulphur and phosphorus. Our conclusion is confirmed when we come to survey the nature of the

* *Jl. Chem. Soc.* (1895) 67. 881.

complex compounds containing carbon, hydrogen, oxygen, and nitrogen—namely, the proteids. We find that they are almost invariably characterised by their feeble stability, and have undoubtedly a comparatively low critical temperature of decomposition. So feeble, indeed, is the general affinity of carbon for hydrogen, oxygen, and nitrogen, that at a red heat the whole of organic chemistry is destroyed.

From the facts discussed in my work, "Researches on the Affinities of the Elements," chap. II., pp. 120-123, it is probable that such a compound would have definite physical characters. For since its atoms attract each other but feebly, the molecules would also attract each other but feebly. It would, therefore, be either of a fluid or semi-fluid nature, and soft. Because its molecules are very great it would not be volatile. Does such a compound exist? I believe so, the compound being nothing more nor less than the protoplasm which forms the basis of living matter. All its chemical and physical characteristics agree with what we should have expected. It is formed out of the four elements, carbon, hydrogen, oxygen, and nitrogen, with small amounts of phosphorus and sulphur; it is of a semi-fluid and soft nature; it is in a state of continual and intermittent change so long as life continues; the temperature of living matter keeps remarkably constant, precisely as it should do on our supposition—a temperature too high exceeding its critical temperature of decomposition and thus destroying its structure, while a temperature too low causes it to cease to decompose and the living matter becomes inactive.

The temperature range of animal life, then, is probably nothing more nor less than the range of the critical temperatures of decomposition of a certain series of very complex carbon compounds grouped together under the name "protoplasm." The external pressure of the atmosphere coincides roughly with the critical pressures of decomposition.

The incessant varying in the external conditions of temperature and pressure, and the external influences, such as radiation and light, which are continually beating upon the earth from external space, are thus the cause of the continuous change characteristic of living matter. In fact, just as a tuning fork is set into motion by vibrations of a certain definite frequency, and by no others, so living matter is so constructed as to respond continuously to the incessant minute fluctuations in the external conditions which hold upon the earth, the state of response being what is known as life.

The difference in the functioning of the different parts of the protoplasm (which exhibits itself in the tendency to produce different organs) is probably due to the different sensitiveness of the different sorts of protoplasm to different specific external influences. Such a differentiation in the nature of the protoplasm in the different organs is probably brought about by the substitution of minute quantities of light or heavy elements for the other elements in its structure. Such a substitution alters to a slight extent the critical temperature of decomposition of the protoplasm, and thus makes it more or less sensitive to certain specific external influences according to specific needs. This probably explains why certain specific heavy elements are retained in considerable quantities in certain organs, and are almost entirely absent from other organs. The different modes of action of the protoplasm are thus probably due solely to the different critical temperatures and pressures of certain parts of the protoplasm.

(*To be continued.*)

The Conservation of Mass.

By ALFRED W. PORTER, B.Sc.
Fellow of, and Assistant Professor of Physics in, University College, London.

(*Continued from December*, 1904.)

II.

In the first part emphasis was placed on the fact that an ordinary balance compares two forces with one another—viz., the *weights* of two bodies—and that the weight of a body is not a satisfactory measure of the amount of stuff in it, because the weight varies from place to place. We further defined another quantity—the *mass* of the body—which was asserted to be a constant for the same body under all conditions. It is our intention now to show that a relation exists between these quantities. For, in fact, the weight of a body is only another term for the action between the body and the earth. These are two bodies which change each other's motion by their mutual influence. The motion of the earth produced by a falling stone is, indeed, too small to be directly observed; and, moreover, as we are on the earth, and move with it, it would in any case be liable to escape our observation. But we nevertheless do not doubt that this case falls in with the general rule that every action is accompanied by an equal but opposite reaction.

If we take this for granted, we may write down an equation for the earth and stone similar to that between the inter-acting billiard balls:—

$$\frac{\text{Mass of stone}}{\text{Mass of earth}} = \frac{\text{increase in velocity of earth.}}{\text{decrease in velocity of stone.}}$$

The time during which the change is observed may be any whatever; but it will be most convenient to refer to the changes in velocity that take place in unit time—that is, to the rate of increase, which is called the *acceleration*. Denoting the masses of stone and earth by the letters m and E, and the accelerations by a and g, the equation becomes

$$\frac{m}{E} = -\frac{a}{g}$$

which may be written

$$mg = -Ea.$$

It is this product which measures the action between the two bodies; mg is the action of the earth on the stone (*i.e.*, its *weight*) whereas $-Ea$ is the opposite and equal reaction of the stone on the earth. The connection between *weight* and *mass* is that the former is the latter multiplied by g (the acceleration while falling freely). Now all experiment goes to show that when disturbing causes are eliminated, all bodies have the same acceleration in the same locality; so that with this restriction as to locality, weight and mass are proportional to one another. On the other hand, the relation between the two is different even for the same body when the locality is changed. For the sake of clearness think of one body alone. In any particular locality it has a certain weight, a certain mass, and a definite acceleration under the action of the earth's pull. In another locality it conceivably has a different weight, mass, and acceleration. In each locality these three quantities are not independent of one another, but are related by the equation

$$\text{Weight} = \text{mass} \times g.$$

And the important question to which an answer must be given is—Can we account for the variation in weight by the variation in g alone, without supposing the mass to vary, or is the mass also subject to variation?

Or again, we take the same substance in a definite locality, but in more than one chemical state, *e.g.*, iodine and silver, at first uncombined and then in the state of combination. The questions to be asked are: Is the weight conserved during the reaction? Is the mass conserved? Is the acceleration *g* conserved?

The question to which most attention has been given, though not always with a clear perception of the issues, is, Does chemical change influence weight?

It is easy to produce a chemical transformation in a closed vessel, and tolerably easy to test on a balance the weight of the contents both before and after the action. Measures were made to this end in 1893 by Landolt on (amongst other things) the combination of silver with iodine, but with uncertain result. Later investigations made by him (in 1900) on the transformation of a ferrous into a ferric salt, in which the clearest evidence of apparent weight was obtained, are unfortunately complicated by the fact that there is here a change also in the magnetic properties. A piece of iron placed in a magnetic field becomes magnetised, and tends to move in it unless the field is quite uniform. Any variation of its magnetism due to a change of its magnetic permeability would entail a corresponding change in the pull from magnetic causes; and this action might conceivably be the cause of the apparent change in weight. Besides, there might be a more direct connection between magnetism and gravity, so that change in one necessarily provoked a change in the other, whether the magnetic field were uniform or not. It is interesting to be reminded that Faraday in 1850 had sought for a connection between electro-magnetism and gravity. He had a "long and constant persuasion that all the forces of Nature are mutually dependent" and although his experiments led to a negative conclusion, yet the results did not shake his "strong feeling of a relation between gravity and electricity, though they give no proof that such a relation exists." Leaving aside some unsatisfactory experiments of Sanford and Ray in America this was the state of affairs in 1901 when Heydweiller, of Breslau, published in "Drude's Annalen" the results of a series of experiments. These were made with every precaution, employing a variety of reactions; and in every case but two a diminution of weight was found to have occurred during the chemical change. The total weight of reacting substance varied from 160 to 280 grammes, and the alteration in weight amounted in one case to more than one-fifth of a gramme. Excluding all those cases in which the observed change did not exceed, or barely exceeded, the expected errors inevitable to the experiments, Heydweiller considers that an alteration of weight has been safely established as taking place (*a*) when iron reacts on alkaline or acid (but not neutral) copper sulphate solution, (*b*) during the solution of acidified copper sulphate in water, and (*c*) during the action of caustic potash on copper sulphate. No conclusion could be arrived at as to the dependence of the change upon the amount of action taking place. Nor does there seem to be any obvious reason why alkaline and acid solutions should exhibit a different behaviour from a neutral one if the change in apparent weight is in reality due to an alteration in gravitational pull. It should be observed that the reactions employed are only mild ones. The impossibility of employing more vigorous ones arises from the necessity of preventing any action from taking place until after the first weighing. The transformation took place in an inverted U-tube, each limb at first containing one of the substances that were afterwards to be mixed. And, indeed, Lord Rayleigh has pointed out that a possible source of error in the experiments is that, even with the materials actually used, some change may have been progressing during the first weighing. If, for example, copper sulphate is in one limb and water in the other, there will not be complete equilibrium; water will distil over to the salt, and although this motion will not directly modify the pull on the balance, since the forces called into play are internal forces, yet thermal change will accompany the evaporation and condensation of the water (the limb containing the water will cool and the other will rise in temperature), and the difference of temperature thereby set up will interfere with the accuracy of weighing owing to the convection currents that it will produce. It must be remembered that the effect observed is only small, and although every endeavour was made to exclude possible sources of error, it must be admitted that the results form a very precarious foundation for theory. The evidence would be strengthened if there were some degree of regularity in the amount of the change; but no regularity exists apart from the fact that the change is negative in all the cases in which it is greater than the expected error. The magnitude of the change observed is well within the powers of a good balance to demonstrate; there is therefore every reason to hope that by the accumulation of evidence all doubt will eventually be removed.

It would be of great theoretic importance to learn that some change does really occur. At present, gravitation is somewhat of a stumbling-block from the point of view of theory. It is so indifferent to circumstances. How is it that the earth pulls a body with sensibly the same force whether a plank (say) is interposed or not? What is the nature of this tie between the two bodies which is not severed thereby? It is true that by inserting a plate of a magnetically indifferent body like copper between two magnets the attraction (or repulsion) between them is not modified. But in what sense can we regard a plank as being gravitationally indifferent? Again, it has recently been shown by Poynting that the pull on a crystal such as quartz, which is a substance that in most respects exhibits different physical properties in different directions, does not sensibly depend upon the orientation of it with respect to the earth. Whether it will turn out or not that the ether is the medium concerned with the transmission of gravity, it is clear that the propagation takes place in practical independence of the structure of the matter through which it passes. From the general physical behaviour of bodies, therefore, it is not to be expected that any modification should be brought about by chemical change which, as far as we know, simply consists in a re-arrangement of the finer parts of which a substance is composed. Any modification, then, which may eventually be demonstrated to take place will introduce a new element into the theoretic consideration of gravity. It will indicate that, from the point of view of this question, the nature of the changes which are dealt with in chemistry are of an essentially different type from the coarser changes which are termed physical. Mixing two substances together may not change their weight, and, in view of Poynting's experiment, we do not expect that it will; but bring about the more intimate chemical union, and the grip of the earth on the body may have changed. The knowledge gained by the final settlement of this question will affect not only gravitational theory, but will have to be taken account of also in the consideration of the exact nature of the forces which come into play in chemical change. On the other hand, if it should turn out that the variations found by Heydweiller are due to unsuspected sources of error, there will be no fact known connecting gravitation with any other physical property of matter.

Although the question of the alteration in weight is not yet settled, it is not premature to consider what is involved in the acceptance of it. We have seen that it is bound up with other questions. Its acceptance involves that there shall also be a change in the mass of the body or in its free acceleration under gravity, or in both. Not long ago a possibility of the change in the mass of a body would not have been considered even except with great reluctance. The constancy of mass has been one of the fundamental tenets of the creators of the present state of physical science. Physicists of the Nineteenth Century would have turned with preference to the alternative possibility. We shall consider these points in the next part in connection with the electrical origin of mass.

(*To be continued.*)

Star Map.—No. 2

Pegasus, Andromeda, and Pisces.

As regards the general configuration of stars, the chief feature included in the present map is the "Square of Pegasus" (although, be it remembered, one of the stars is not in Pegasus). This will be easily recognised near the centre of the map, and in the actual heavens is a ready means of determining the true North. At the top of the map is the greater portion of Cassiopeia, which constellation is included complete in Map I.

One of the most remarkable objects within this region is the Great Nebula in Andromeda (R.A. oh. 38m. Dec. 40 45' N.), one of the few visible to the naked eye. This was the first nebula noted, having been described long before telescopes were invented. It is of elliptical shape, and when viewed in a powerful telescope it seems to consist of a number of rings with bright centre, presenting an appearance somewhat similar to a hazy view of Saturn. The spectrum of this nebula is continuous, and would therefore be that derived from a large number of stars of different compositions. Hence it has been inferred that this object may be in reality a vast group of very distant stars, and not a gaseous nebula. In 1885 a "Nova" burst forth in this nebula.

γ *Andromedæ* (I. h. 5·m. + 41 51') is a fine triple star. Two stars, magnitude 2½ yellow, and 5½ blue green, are at a distance of 10"·2, and the latter seen in a powerful telescope resolves itself into a binary at a distance of 0"·45. Near this another peculiar nebula of very elongated form occurs.

α, η, and σ Cassiopeiæ, as well as *δ Cephei*, are double stars, the first and last named being also variables which have already been referred to in the description of Map I.

γ *Arietis* (I. h. 48m. + 18 49') is one of the earliest discovered double stars, magnitude 4 2 and 4·4, distance 8"·3.

ι *Trianguli* (II. h. 7 m. + 2 , 50') is a double star, one 5th magnitude yellow, the other 7th magnitude blue. Distance 3"·5.

μ *Cygni* (XXI h. 40m. + 28 18') is a double star, of 4th and 5th magnitudes. Distance 2"·

ζ *Aquarii* (XXII. h 24m. — 0° 32'), double star, both of 4th magnitude. Distance 3"·1.

(Star Map No. 1 (North Polar Regions) appeared in the May number.)

The Nation's Latest Acquisition.

By W. P. Pycraft, A.L.S., F.Z.S., &c.

"There are no examples of *Diplodocus* at present in the collection." Such is the statement to be found in the Guide to the Geological Galleries of the British Museum. To-day, thanks to the generosity of Mr. Carnegie, this gap has been filled by the splendid gift of a replica of the magnificent specimen of this enormous creature in the Carnegie Museum at Pittsburg. Since the Dinosaurs hold so important a place among the reptiles, a short account of the remarkable specimen just added to our National Natural History treasure-house may be of interest to many readers of "Knowledge."

Diplodocus Carnegii, as this specimen has been named, represents one of the largest land animals known, measuring some eighty-four feet from tip of snout to tip of tail, and between thirteen and fourteen feet high at the top of the haunches. Of this enormous length, over fifty feet belong to the tail, and about twenty to the neck. Apart from its great length, the vertebral column is remarkable in several particulars. The neck vertebræ, fifteen in number, recall those of birds, in their great pneumaticity, as well as in the shape and disposition of the cervical ribs. The neural spines of the thoracic vertebræ are of great height, as one would expect from the great length of the neck. But the caudals, perhaps, are the most interesting. These taper rapidly, terminating eventually in a number of long cylindrical vertebræ forming a whip-like termination to this appendage. Whether this peculiarity is the result of degeneration, or whether of specialization to some peculiar function, is not known, but the former is probably the case. At the place where the tail first rests upon the ground two separate sets of two vertebræ each are found to be firmly fused together. Prof. Osborn suggests that this fusion is the result of mechanical strain brought about by the use of the tail to form a tripod, inasmuch as this beast, he believes, was in the habit of rearing itself upon its hind legs, after the fashion of a kangaroo. An examination of these vertebræ, however, rather seems to show that this fusion is the result of injury. The whole aspect of the animal seems to contradict the possibility of any such aerobatic feats as standing erect.

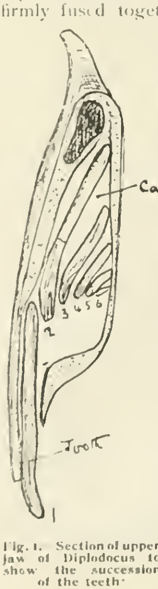
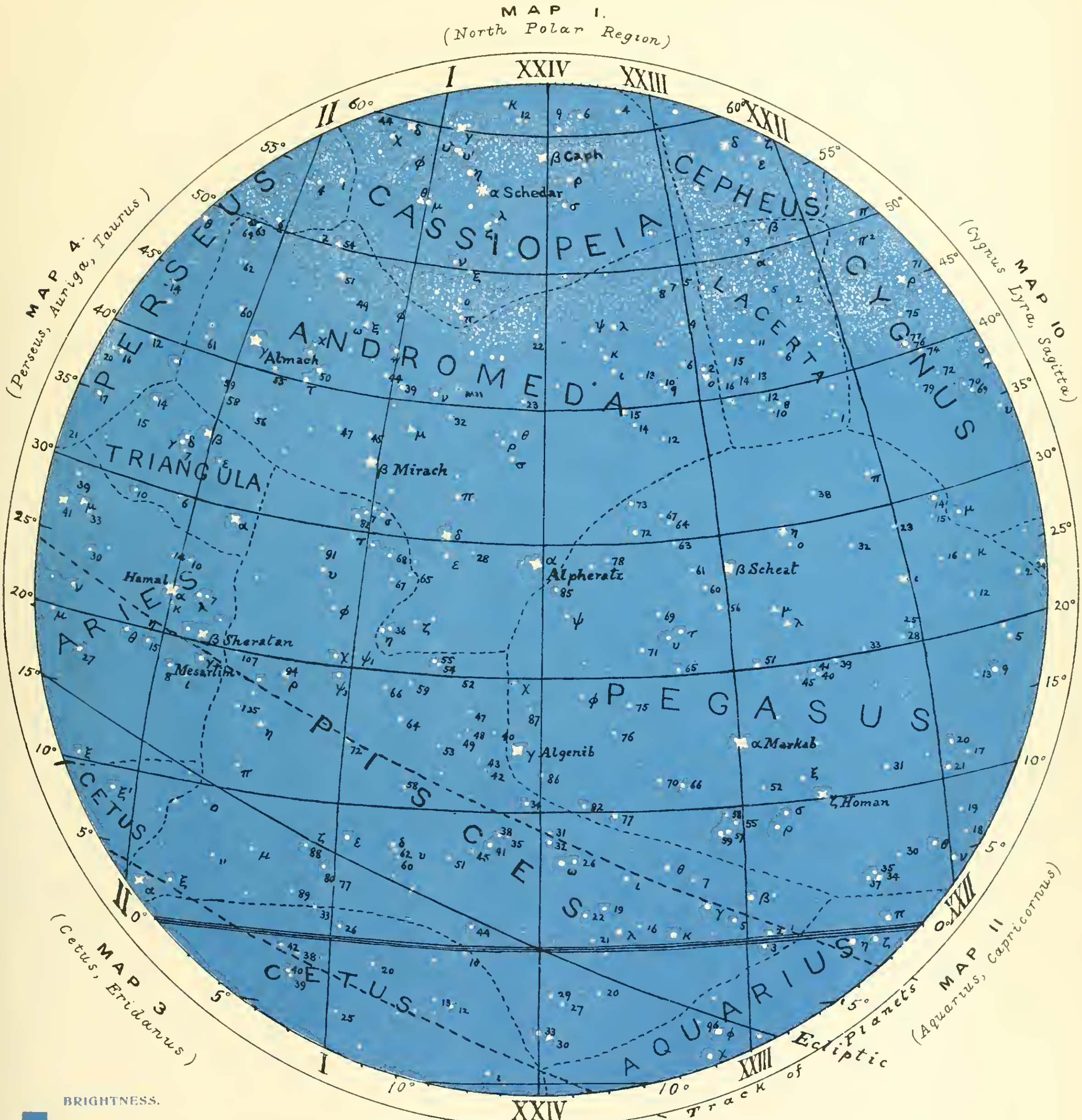


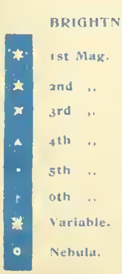
Fig. 1. Section of upper jaw of Diplodocus to show the succession of the teeth.

The pillar-shaped legs terminated in five short, stout toes, of which the three innermost on each foot bore large claws, which, it is significant to note, are twisted outwardly. The outermost digits were clawless.

The skull, which was about two feet in length, is curiously flattened, presents a rounded muzzle, and an extraordinarily small brain cavity; so small, that the brain has been described as scarcely larger than a large walnut! Teeth were confined to the fore part of the jaws,

MAP No. 2.





MAP No. 2.

Pegasus, Andromeda, and Pisces.

and were long and peg-like; as worn out they were replaced in constant succession. The manner of this replacement is indicated in Fig. 1, which shows a section through the upper jaw.

It has been suggested that this monster was largely aquatic in its habits, partly on account of its enormous bulk, and partly because of the position of the nostrils. These opened, not at the end of the snout, but in the form of a large hole between the eyes—the white shield in the front of the skull in the photograph. There can be little room for doubt, indeed, but that the peculiar position of these apertures represents an adaptation to an aquatic habitat. Probably Diplodocus, like the modern hippopotamus, passed most of its time submerged in rivers, and thrust the head out of the water

Replica of Diplodocus. (*From the original in the Carnegie Museum at Pittsburg.*)

at intervals, just far enough to enable breathing to take place. Here it lived upon succulent vegetation, which was torn up by the rake-like teeth.

The causes which led to the extinction of this monster, and of others of like kind, will always remain a mystery. These leviathans represent the high-water mark attained by the reptiles, and it is significant to note that they disappeared just as the mammals were entering the arena of life. The late Prof. Cope, indeed, suggested that these early mammals (Jurassic) played no small part in the overthrow of their giant neighbours; that beasts of the size of the shrew and hedgehog hunted out the nests of these colossal creatures and gnawing through the shells of the eggs, destroyed the young. This explanation savours rather of wild conjecture than scientific reasoning. It seems more probable that the Dinosaurs were viviparous.

A more plausible hypothesis as to the causes of extinction of Dinosaurs, and other animals which have attained huge proportions, is that of Dr. C. W. Andrews. "An almost necessary corollary," he remarks, "of this increase in bulk, is . . . the lengthening of the time taken to attain sexual maturity . . . . A necessary consequence of the longer individual life will be that in a given period fewer generations will succeed one another, and the rate of evolution of the stock will, therefore, be lowered in the same proportion. If, now, the conditions of life undergo change, the question whether a given group of animals will survive or become extinct, will depend upon whether it can undergo sufficiently rapid variation to enable it to avoid getting so far out of harmony with its surroundings that further existence becomes impossible. . . ."

Finally, it may be well to remind our readers that the great American continent has by no means the monopoly of these titanic Dinosaurian beasts. In the British Museum, for example, there may be seen the limbs of an enormous Dinosaur known as *Cetiosaurius*, obtained some years ago in Oxford. This creature must have rivalled Diplodocus in size. The Great Iguanodon, again, which once roamed over our islands, might well have disputed the right of way with Diplodocus, inasmuch as it stood some 18 feet high, and had the fore limbs armed with powerful spurs. But of these, and others, we may have more to say on another occasion.

Rare Living Animals in London.

By P. L. SCLATER, DR.SC., F.R.S.

V.—Scoresby's Gull (*Leucophæus scoresbii*).

THIS well-marked species of gull was first described in 1823 by the late Dr. T. S. Trail in a paper read before the Wernerian Society of Natural History, and subsequently published in the fourth volume of that Society's "Proceedings." It was named by Trail after Scoresby, the "celebrated Navigator of Icy Seas," and the description was based on a specimen, then in the Museum of the Royal Institution at Liverpool, which had been brought home by one of the ships of that port engaged in the whale-fishery at the South Shetland Islands. Scoresby's gull is, in fact, exclusively an inhabitant of the Antarctic seas, and does not occur in the North Polar region, where the navigator after whom it is named made so many discoveries. Vigors had, no doubt, overlooked Trail's description, or he would not have renamed this bird in 1828, when it was called by him *Larus hæmatorhynchus* from its bright red bill, and was subsequently figured under the same name by Jardine and Selby in their "Illustrations of Ornithology." Vigors' specimens were procured by Capt. King at Port Famine in Patagonia, during the voyage of the *Beagle*, and nearly all the subsequent explorers of the coasts of the Magellan-Straits and Cape Horn appear to have met with this gull, which seems to be by no means uncommon in far southern latitudes.

This gull also inhabits the Falkland Islands, and, as recorded by Capt. Abbott, breeds there in December, "frequently laying its two eggs in the communities of the large Dominican Gull, *Larus dominicanus*, but it also has separate breeding-places." Eggs received from Capt. Abbott are in the collection of the British Museum.

More recent intelligence respecting Scoresby's Gull in the Falkland Islands has lately been procured by Mr. Rupert Vallentin, who informs us* that this bird, locally called "The Dolphin," is fairly common in the neighbourhood of Stanley, Port Louis, and Roy Cove, but that none were seen after the end of February. At Stanley and Port Arthur both adult and young specimens were always to be met with near the slaughter-houses in quest of offal in the months of November and December. At Roy Cove Mr. Vallentin frequently observed them walking on the floating beds of kelp and feeding on the crustaceans attracted thither by the decaying seaweeds.

V.—Scoresby's Gull.

By recent authorities Scoresby's Gull has been separated from the more typical forms under the generic title *Leucophæus*. Mr. Howard Saunders, our principal authority on this group of birds, points out that it has "a remarkably short, stout crimson bill, coarse feet with somewhat excised webs, and a decided hood in the immature stage, which wears off as the bird attains adult plumage." These characters were fully shown in the two specimens of this remarkable species which reached the Zoological Society's Gardens in October, 1903. One of these died in February, 1904, the other, which is still living, is the original of the accompanying drawing by Mr. Goodchild. So far as I know these are the only specimens of this bird that have ever been brought alive to Europe.

* "*Manchester Memoirs*," Vol XLVIII. (1904), No. 23.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Tenth Satellite of Saturn.

Another interesting communication from the Harvard College Observatory announces the discovery by Professor W. H. Pickering of a new satellite to the planet Saturn, bringing the number of its attendants up to ten. The period of revolution of the new satellite is stated to be 21 days, which is very nearly equal to that of the seventh satellite Hyperion. The body is evidently extremely faint, as it is estimated to be three magnitudes fainter than Hyperion (which is about 17), so that it is doubtful if the new object will be detected visually for some time. The orbital motion is believed to be direct.

* * *

Seasonal Changes on Mars.

A telegraphic communication from Cambridge, U.S.A., announces that Mr. Percival Lowell, at the Flagstaff Observatory, Arizona, has again detected the evidence of seasonal changes on the Martian surface during the present opposition. The observational evidence consists chiefly of colour changes on the various well-known areas, and was first noticed by Lampland on April 4. The most prominent feature is seen in the Mare Erythræum, just above the Syrtis, which has again altered from blue-green to chocolate-brown. The Martian season at the time of observation, April 9, corresponded to the terrestrial February.

* * *

The Lens Mirror Telescope.

In an excellently-worded booklet, Mr. G. Whittle, of Liverpool, describes the construction of a new form of lens-mirror telescope that he has recently devised. In this the reflecting surface consists of the back of the lens, which is silvered and varnished, thus being completely protected from deterioration. Moreover, the length of the telescope body is greatly reduced. The lens adopted is a concave-convex for the main mirror, and a small meniscus is employed near the focus as a secondary mirror on the Gregorian plan for magnification. We have not had the opportunity of using the instrument, but its adaptability is stated to depend mainly on its absolute achromatism, and perfect *internal* reflection from a surface of pure silver deposited on a true surface of optical glass.

The Gregorian mounting has been chosen on account of the resulting image being in an erect position.

* * *

The New Solar Observatory on Mount Wilson in California.

Recent changes in the arrangement of the staff of the Yerkes Observatory, resulting in the transference of its former Director, Professor G. E. Hale, to the superintendence of the new solar observatory established by the Carnegie Institution on Mount Wilson, Pasadena, California, will probably mark an important epoch in the progress of scientific astronomical investigation.

It was only after very exhaustive preliminary tests that this station was selected by Professor Hale and his colleagues, and the numerous data supplied fully support their decision. Situated at an elevation of nearly 6000 feet, the station affords exceptional facilities for many solar investigations which cannot be efficiently carried out at places nearer sea-level. The plan of work outlined for the Institution includes:—

1. Frequent measurements of the heat radiation of the sun to determine whether there may be changes during the sun-spot cycle in the amount of heat received from the sun by the earth, and in the relative radiation of the various portions of the solar surface.
2. Studies of various solar phenomena, particularly through the use of powerful spectroscopes and spectroheliographs.
3. Photographic and spectroscopic investigations of the stars and nebulæ with a very powerful reflecting telescope, for the principal purpose of throwing light on the problem of stellar evolution.

From the records now in existence, it appears that solar observations will be possible on 300 days of the year, and the mean daily range of temperature only varies from 18·5° F. in April to 27·1° F. in November. The anemometer records indicate that the average wind movement is exceptionally low, indicating a uniform atmosphere. Operations were started with a 15-inch coelostat and a lens of 6 inches aperture and 61½ feet focal length, and many interesting observations made on the effect of heated air rising from the ground across the sight line of the instrument. By raising the piers as far as possible above the ground and taking special precautions for eliminating variations of temperature in the observing room, it has been found possible to obtain much better definition than usual.

Associated with Professor Hale in the new institution are Messrs. Ritchey, Ellerman, and Adams, all from the Yerkes Observatory. They hope to have the 5-foot Snow reflector available for use very shortly. Two concave mirrors of 24 inches (61 cm.) aperture, 60 feet (18·3 m.) and 145 feet (44·2 m.) focal length respectively are to be used for forming the primary images of the solar disc. The spectroscopic apparatus to be used in conjunction consists of:—

1. A spectroheliograph with portrait lenses of 8 inches (20·3 cm.) aperture and 60 inches (152 cm.) focal length, provided with four dense flint prisms. This will be floated in mercury, to reduce the friction on the rolling surfaces. Daily photographs of the entire solar disc with the calcium and hydrogen lines will be taken with this, using the image of 6·7 inches (17 cm.) diameter given by the concave mirror of 60 feet focal length.
2. A spectroheliograph of 5 inches (12·7 cm.) aperture and 30 feet (9·14 m.) focal length, provided with three light flint prisms of 50° angles. In this instrument the spectroheliograph will remain fixed, and the traverse of the image across the slit obtained by a slight rotation of the large mirror, and a corresponding motion of the photographic plate. The whole will be used for studying special zones of the solar image, and with a plane grating, for the study of sun spots, &c.
3. A Littrow spectroscope of 18 feet (5·49 m.) focal length, with large plane grating, to be used for study of solar rotation and spectrum of sun spots.
4. A large concave grating stellar spectrograph, of about 15 feet (4·57 m.) equivalent focal length, used with a collimating lens of 5 inches (12·7 cm.) aperture to eliminate astigmatism.
5. A prism spectrograph, with collimator of 1½ inches (3·8 cm.) aperture and 48 inches (114·5 cm.) focal length; dispersion train of one to four prisms, and various camera lenses. This will be used in the determination of wave lengths of stellar spectra, especially in the ultra violet regions.

The activity of Professor Hale and his staff is well shown by the recent publication of a beautiful reproduction from a photographic spectrum of the solar surface. This shows the violet region, including the H and K lines of calcium, which are about 4½ inches apart. This photograph was obtained at Mount Wilson with the Littrow spectrograph above mentioned, the grating being 4 inches in aperture with 14,438 lines to the inch, using the third order. An interesting feature of the photograph is the strength of the reversals over the regions occupied by faculæ on the sun's disc, and the scale is sufficient to show clearly that the continuous spectrum of the faculæ rapidly decreases in intensity as it approaches the centre of H_1 and K_1, where it almost disappears. This fact will prove most useful in future theoretical considerations.

Ephemeris for Observations of Comet 1904 II.

(12h., Berlin Mean Time)

1905.	R.A. h.	m.	s.	Declination. °	'	Relative Brightness.
June 1	2	35	42	+ 64	50·8	0·16
3		39	27		51·6	
5		43	5		52·6	0·15
7		46	37		53·7	
9		50	3		55·1	0·15
11		53	23		56·7	
13		56	36	64	58·5	0·14
15	2	59	43	65	0·5	
17	3	2	44		2·8	0·14
19		5	39		5·3	
21		8	28		8·1	0·13
23		11	11		11·1	
25		13	48		14·3	0·13
27		16	19		17·8	
29		18	43		21·5	0·12
July 1		21	1		25·4	
3		23	13		29·5	0·12
5		25	18		33·0	
7		27	17		38·5	0·12
9		29	9		43·2	
11	3	30	53	+ 65	48·2	0·12

CHEMICAL.

By C. A. Mitchell, B.A. (Oxon.), F.I.C.

New Experiments on the Making of Diamonds.

A block of meteoritic iron from Cañon Diablo was recently examined by Professor Moissan, and its composition suggested improvements in the artificial manufacture of diamonds. A section of the meteorite contained numerous diamonds, both black and transparent, together with amorphous carbon (graphite), and phosphorus and sulphur combined with iron. Experiments were therefore made to determine the influence of sulphur, silicon, and phosphorus upon the crystallisation of carbon under the artificial conditions of the laboratory. Iron was fused with a large excess of sugar in a crucible in an electric furnace, and as soon as the molten iron had become saturated with carbon (derived from the sugar) a small proportion of iron sulphide was introduced, and the crucible then rapidly cooled by immersion in cold water. It was found that the carbon had crystallised out in diamonds from the centre of the mass, and that the iron sulphide had considerably increased the yield of crystals. Rapid cooling of the fused mass, however, was essential, for otherwise no diamonds were formed. Silicon also promoted the crystallisation of the carbon, but phosphorus had no effect upon the results.

* * *

The Specific Serum Test as a Proof of Evolution.

Professor Haeckel in his latest work the "Evolution of Man," cites the recent results of physiological chemistry as additional proofs of the origin of man. Although a serum that has been rendered specific for one species of animal should give no precipitate with the sera of other animals (see Knowledge & Scientific News this vol. p. 86), the test breaks down in the case of animals of very closely allied species, and hence it is not surprising that a preparation that has been made specific for human serum should also react with the serum of an anthropoid ape and *vice versa*. It would thus be impossible to infer that a given stain consisted of human blood if there were a possibility of an anthropoid ape having been near the place. Another possible source of error in the serum test has been pointed out by MM. Linossier and Lemoine, who find that the differences are not so pronounced as has been asserted. They state that if solutions of too great a concentration be employed, the prepared sera are no longer absolutely specific, although the precipitates are much more marked with the serum of an animal of the particular species in question than with the sera of animals of other species. To obviate this error they recommend that the solutions employed should not contain more than one part in a thousand.

* * *

The Preparation of Pure Tantalum.

The rare metal tantalum occurs in various minerals, such as niobite, tantalite, and samarskite, and is usually found in association with another rare metal, niobium. Hatchett, in 1801, came to the conclusion that some of these minerals contained a new element, and different chemical compounds containing it were subsequently prepared. It is only quite recently, however, that Dr. W. von Bolton has succeeded in preparing the metal in a state of purity, and in his opinion the substance prepared by M. Moissan in his electric furnace was contaminated with carbon. Dr. Bolton's method of obtaining it consists in passing an electric current through a filament of brown tantalum oxide in a globe from which the air has been previously exhausted by means of a vacuum pump. This causes oxygen to be evolved from the incandescent filament, which gradually turns grey as it is reduced to the metallic state. Tantalum can also be prepared by fusing tantalum fluoride with potassium in a vacuum by means of an electric furnace. Metallic tantalum, which has an atomic weight of about 180, is extremely ductile. When the sheets are again heated and hammered they become extremely hard, and the metal may find a possible use as a substitute for the diamond in drills. Tantalum resists the action of acids, including *aqua regia*, and it can be heated to redness in the air without burning. It forms alloys with many other metals, but apparently does not amalgamate with mercury. When combined with about one per cent. of carbon it becomes very brittle. Messrs. Siemens and Halske have employed filaments of tantalum for electric incandescent lamps, and as a length of over 20 inches is necessary for a lamp of 22-candle power, they have constructed a special lamp for the purpose. The central support for the filament is of glass and has a number of radiating supports over which the wire is stretched. This lamp is stated to consume only half the electric energy required by the ordinary incandescent lamp, while a pound of the tantalum is sufficient for more than 20,000 lamps, so that a great saving is effected by its use.

GEOLOGICAL.

By Edward A. Martin, F.G.S.

Gravels on South Norwood Hill.

We have received a communication from Mr. J. K. Larkby in regard to the reputed eoliths found at the top of the hill by Mr. N. F. Robarts, F.G.S., two years ago, to which a reference was made last month. He has been unable to accept the flints as true eoliths, and it is to fair to say that others have questioned their authenticity. On the other hand they have been accepted as of human workmanship by many of the best local geologists, and they deserve mention in any work dealing with implementiferous gravels. We shall all agree with Mr. Larkby when he says: "Whilst fully accepting the artificial nature of eolithic forms, I recognise that the indiscriminate admission of evidence must serve to confirm the impression that the acceptor of eoliths is *ipso facto* a 'crank.'"

* * *

A Lost River.

The gravel which is found along the valley which leads from Caterham to Purley gives evidence of an important river which at one time flowed here. Early last year there was evidence of the stream in the rising again of what is known locally as the Bourne. This had not flowed since 1896, although previous flowings had generally occurred at shorter intervals. The rising of the feeders were to be seen at various spots in the valley, extending from the grounds of the "Rose and Crown" at Warlingham, where they were seen bubbling up at several places, notably on the site of the cocoa-nut pitch, to the gas-

works farther up. At Kenley, where building has been going on for some time, the gravel has been excavated and sifted. In a heap of gravel which I examined, in addition to a great number of sub-angular flints, there was a fair proportion of rounded stones and pebbles, of Oldhaven pebble-bed origin. Many of the flints had become encrusted with a covering of lime, after the manner of the action of so-called petrifying springs. Lumps of conglomerate were also found, and occasional pieces of red sandstone. The limestone encrustation of some of the flints clearly showed the present origin of the feeding springs from the chalk, whilst the presence of the sandstones takes one back to times when the river had a portion of its flow over the Lower Greensand farther south, and possibly over some of the sandstone beds of the Weald.

* * *

Pre-Glacial Valleys of the Northumberland and Durham Coalfield.

By a detailed examination of about 600 different borings in the area specified, Dr. D. Woolacott, F.G.S., has reconstructed with considerable pains some of the valleys which existed prior to the Ice Period, many of which have been completely hidden since by thick wrappings of boulder-clay. Although the subsequent existing drainage systems of boulder-clay areas are in most cases much the same as those on which they were superimposed, there are notable cases in which the subsequent drainage has been completely different to that previously obtaining. The greatest thickness of superficial deposits found was that at Newton Hall, in the Wash valley, when 233 feet of these lay above the old rock surface. A number of the borings show the rock-surface at a considerable depth below sea-level, such at Burdon Main, in the Tyne valley, where the rock was not reached except at a depth of 141 feet, this affording good evidence of considerable subsidence, as compared with pre-glacial times.

* * *

The Great Peak Fault.

In the course of a paper read before the Geological Society by Mr. R. H. Rustall, B.A., on the Blea-Wyke Beds and the "Dogger" in N.E. Yorkshire, the subject of the age of this well-known fault was touched upon. The author leaned to the view that it was partly of pre-Oolitic date. There is every reason to think, as suggested by Mr. Hudleston many years ago, that the fault was a distinct line of weakness, and that probably movement had taken place more than once in the history of the district. Disturbances in the earth's crust were apt to follow old lines.

* * *

Earthquake in England.

A reminder on a small scale of the earthquake convulsions which have taken place recently in India was experienced in the Midlands on the early morning of Easter Sunday. It is not improbable that the shock had a connection with the Indian catastrophe. The crust of the earth will for some time be occupied in settling down, so to speak, into greater permanency than it was left after the great underground earthslides which gave rise to the Lahore shocks. In fact, any one great quake may generally be regarded as the forerunner of other minor ones, and the shocks so caused may travel to regions where earthquakes are infrequent.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., B.O.U., &c.

Greenland Falcon in Co. Donegal.

In the *Irish Naturalist* for May, Mr. Robert Patterson records the occurrence of a Greenland Falcon at Horn Head, Dunfanghy, on March 21. The bird was taken in a trap, and proved to be a female. The total length of this bird from the tip of the beak to the tip of the tail was 1 ft. 11 ins.; the expanse of the wing 4 ft. 3 ins. The weight is not recorded.

Corn Crake in Winter.

Though it is now generally believed that the Corn Crake not seldom remains throughout the winter in Ireland, authenticated instances of this stay are valuable. Mr. Robert Patterson records in the *Irish Naturalist* for May the fact that one of these birds was shot near Lurgan in January last. In England such cases are very rare.

* * *

Bittern in Co. Wexford.

One of these unfortunate birds was shot in November, 1904, at Curracloe, near Wexford. According to Mr. J. H. Johnson, who records this occurrence, a Mr. O'Neill heard the booming near his house. This statement requires some qualification, as the Bittern is generally believed to utter this note only during the breeding season.

* * *

Snowy Owl in the Shetlands.

One of these birds was killed in November last, according to the *Annals of Scottish Natural History* for April (which reached us too late for comment last month) at Ballinata. No particulars are given as to sex or measurements. News has just come to hand of another Snowy Owl killed in Norfolk during April last. Further particulars thereof we hope to give next month.

* * *

Albino Redshank in the Outer Hebrides.

A so-called albino Redshank was killed in October last in the Outer Hebrides, according to the *Annals of Scottish Natural History* for April. This bird, however, should rather have been described as isabelline and white, inasmuch as buff and cinnamon appeared conspicuously in the plumage intermixed with white. In true albinos, *all* pigment is wanting; hence the pink iris, which is hall-mark of the albino.

* * *

Arrival of Summer Birds.

From *The Field* for April 22 we gather the following list:—

Garden Warbler	—St. Neots...	April 13
Nightingale	„	„ 15
„	Eastbourne	„ 12
„	Tonbridge	„ 15
„	Shoreham	„ 15
„	Shere	„ 16
„	Hockley	„ 16
Landrail	Barnstaple	„ 12

PHYSICAL.

By Alfred W. Porter, B.Sc.

All who had the privilege of listening to Professor Nichols (of Columbia University, New York) at the Royal Institution, on the 12th May, were delighted with the apparent ease with which a difficult experiment was shown. The subject of the lecture was "The Pressure due to Radiation." It had been predicted by Maxwell that if his electro-magnetic theory were true, light falling on a body should repel it, and he calculated the force of the repulsion which would correspond to a particular amount of light; but this was exceedingly small. Crookes at first thought he had obtained experimental evidence of this pressure when he discovered that light vanes, mounted in a partial vacuum so as to be capable of easy rotation, were set in motion when one side of each face was blackened and light fell on the blackened face. This action, however, was afterwards traced to the effect of heat and not to light, and depends upon the presence of residual air in the exhausted vessel.

This air effect, when at a maximum, is thousands of times as great as the effect which would exist if no air were present; and it is its presence which creates the chief difficulty in measuring the pressure due to radiation itself.

The apparatus employed by Professors Nichols and Hull consists of two light mirrors mounted on a horizontal capillary glass tube which is suspended at its middle by a quartz fibre about an inch long. When a strong light (from the sun or electric arc) is focussed on one of the mirrors, it drives it back and thereby twists the fibre. The angle through which the suspended mirrors turn can be observed by reflecting a second beam of light from another mirror mounted on the axis of rotation.

The chief beauty of the experiment consisted in showing that for a particular pressure of the air the disturbance arising from it is almost zero; and most of their measurements were therefore made at this pressure. But even at other pressures *the first motion of the suspended vanes is always due to the radiation.* The reason of this is that the pressure due to the radiation acts instantaneously; but the air effect depends upon the vanes gradually warming up, so that the action arising therefrom is always delayed.

The results of Nichols' and Hull's experiments are in satisfactory agreement with Maxwell's theory.

ZOOLOGICAL.

By R. LYDEKKER.

The Pelagic Lancelet.

THE border-land between vertebrates and invertebrates naturally possesses an interest surpassing that which attaches to what we call ordinary members of the animal kingdom; that is to say, to those which conform more or less completely to a normal type and possess a host of near relations. One of the most remarkable of these inhabitants of the border-land is the tiny translucent creature of little more than an inch in length not uncommon on sandy shores in the Mediterranean, to which our great ichthyologist gave the appropriate designation of lancelet. Long considered a fish, it is now regarded as more nearly related to the sea-squirts, or ascidians; and with the latter is ranked as chordate rather than a vertebrate animal. Among its many peculiarities is the absence of any distinct head, the position of the mouth on the under surface of the anterior end of the body, and the ring of tentacles with which the opening of the mouth is surrounded. Many kinds of lancelets are now known, all save one of which conform more or less closely to the general type. The exception is a species long represented only by a single specimen taken during the scientific cruise of H.M.S. *Challenger* in the open sea. Of this species a number of specimens have recently been described, and these serve to show that it is a very distinct type indeed, characterised not only by its pelagic habitat, but by the position of the mouth on one side of the body, the absence of the ring of tentacles fringing the mouth-opening, and several other equally important structural peculiarities.

* * *

Luminous Shrimps.

The Prince of Monaco, whose active interest in the fauna of the deep sea is well known, is reported to have lately discovered luminous shrimps, which live at a great depth where all, of course, is dark. When placed in aquariums these crustaceans soon, however, loose their luminous properties. Probably most, if not all, abyssal organisms are luminiferous, or phosphorescent, some giving forth light from the general surface of the body, and others from special organs.

* * *

The Carnegie Dinosaur.

On May 12th, Lord Avebury, on behalf of the Trustees, formally received from Mr. Carnegie the gift of a model of the skeleton of the great dinosaurian reptile *Diplodocus carnegii*, which has been recently set up in the reptile gallery of the Natural History Museum under the immediate superintendence of Dr. Holland, Director of the Carnegie Museum at Pittsburg. The skeleton, as now set up, gives a far better idea of the enormous proportions attained by these gigantic reptiles than was ever previously possible in this country, even with the aid of the imperfect skeleton in the Geological Department of the Museum collected by Mr. A. N. Leeds, near Peterborough. The skeletons from which the model in the Museum were constructed were obtained from the Upper Jurassic formation of Colorado and Wyoming; from which horizon the late Prof. Marsh long since secured the remains of the typical species to which he gave the name *Diplodocus longus*. As set up, the skeleton measures about 75 feet in length, but were the skull and vertebræ arranged in a straight line the length would be some ten feet more. At the shoulder the creature stands about 14 feet in height. The skeleton is mounted with the head and neck stretched out nearly in the line of the back; but we may be permitted to doubt whether this was the normal attitude of the reptile in life, especially in view of the fact that the nostrils opened on the top of the head, which suggests an amphibious existence. *Diplodocus* differs from its relatives by its feeble teeth, which resemble lead-pencils, and are confined to the front of the jaws. Such a feeble dentition suggests that the creature procured its food in the water. By his munificent gift Mr. Carnegie has laid all in this country who are interested in natural history under a deep obligation.

* * *

Fossil Marmot Burrows.

Some years ago American geologists described certain large spirals of hard stone met with in rocks of soft structure under the name of "devil's corkscrews," or, more scientifically, as *Dæmonohelix*. How these strange and gigantic spirals were formed had long been a mystery, although some naturalists suggested that they were of vegetable origin. Dr. Holland has explained that they are really the solidified burrows of a marmot allied to the existing "prairie-dog" (*Cynomys ludovicianus*). Hence, we presume, *Dæmonohelix* becomes the generic name of a mammal.

* * *

The Man-like Apes.

Naturalists will probably be divided in opinion as to the value of Mr. Rothschild's paper on anthropoid apes in the April number of the Zoological Society's *Proceedings*, and some of them, at any rate, will not endorse all his views with regard to the nomenclature. One of the most interesting observations records the fact that two different types of orang-utans are to be met in the same districts, in one of which the faces of the old males are expanded into a kind of warming-pan shape, while in the other they are of more normal contour. Mr. Rothschild explains this by "dimorphism," and regards both types as belonging to a single species, and even to the same race. Among chimpanzis two distinct types are likewise stated to inhabit the same districts, but here the author regards the two forms as separate species, each of which may have several local races. Whether this explanation of a very curious puzzle will be generally accepted remains to be seen.

* * *

Papers Read.

At the meeting of the Zoological Society on April 18th Dr. A. Smith Woodward read a paper on the skeleton of *Cetiosaurus* (or, as being derived, κῆτη, *Ceteosaurus*) *oxoniensis* from the Oxford clay of Peterborough; while the Secretary described a young Nigerian giraffe (*Giraffa camelopardalis peralta*). As mentioned in our last issue, Mr. A. E. Shipley described various internal parasites obtained in the Society's Gardens and elsewhere, and Mr. R. H. Burns discussed the anatomy of the leathery turtle. Messrs. Thomas and Schwann gave an account of a collection of South African quadrupeds, Mr. G. A. Boulenger described a new Yunnan newt, Dr. E. Lönnberg noticed hybrid European hares, and Mr. A. L. Butler referred to the giant eland of the Bahr el-Ghazal. The papers read on May 2nd included one, by Prof. Minchin, on sponges of the group *Leucoselenia*, &c., a second, by Mr. Beddard, on the anatomy of the ferret-badger, and a third, by Mr. W. P. Pycraft, on the osteology and affinities of the birds of the family *Eurylæmidæ*.

REVIEWS OF BOOKS.

The Principles of Heredity. G. Archdall Reid, M.B., F.R.S.E. (Chapman and Hall, 1905.) This volume is, we are told, addressed to medical men, the evidence relied upon being largely drawn from medical sources. Nevertheless the author has so consistently avoided the use of technical language, and his reasoning is so clear and acute, that it should prove very interesting to the general reader.

The author commences with a chapter upon the "Theories of Heredity," following on with chapters upon "Theories of Evolution, Use and Disuse, and Spontaneous Variation." In these chapters he reviews the main features of the evolutionary theory, as accepted by the majority of biologists of the present day. The Bathmic theory and the Lamarchian theories are dismissed as fundamentally opposed to observed facts, there being little or no evidence to justify belief in the inheritance of acquired characters, even in the lower forms of life. The theory that organisms are gradually adjusted to their environment by processes of variation and selection is accepted.

The effects of use and disuse are dealt with in a lucid and most suggestive manner. Man and the higher animals are described as large superstructures of "acquirements" built upon comparatively slender foundations of inborn characters. The hair, the teeth, the nose, the nails, &c., are wholly inborn characters, and are quite unaffected by use and disuse, but the muscles of the legs and other limbs, the heart, the blood vessels, the lungs, &c., can only reach their proper development by acquirement, and can only be maintained by the exercise necessary for their acquirement. It is thus clear that the modifications resulting from use and disuse are not transmitted to subsequent generations, but only the power of acquiring modifications under similar circumstances.

Under the title of "Recapitulation" the author endeavours to establish and remodel the old theory that the development of the individual is a blurred recapitulation of the history of the race. This theory, as stated by Mr. Reid, like the many other theories of "Heredity," contains much truth, but not the whole truth. Each theory may form a stepping-stone to some final and completely satisfactory laws of heredity, but one feels that the pressing need of the moment is work. The laws governing the inorganic world were established by a host of workers experimenting until a mass of organised knowledge was accumulated which placed those laws beyond dispute. Each new work upon this subject impresses one that students of heredity rely too much upon empirical observation, and upon the work of the practical man in rearing animals and plants. Such sources of knowledge are too incomplete and disconnected to enable us to attain a complete knowledge of this important subject.

Under the title of "Biparental Reproduction" we are told that its tendency is to result in regression to the specific mean, and that there is not an iota of evidence to prove that biparental reproduction is connected with variation as a cause and effect. The author appears to disregard the fact that in the words of E. Ray Lancaster*: "Breeders of horses, cattle, and sheep, and dog, pigeon and poultry fanciers, crop growers, nurserymen, tulip maniacs, and the like . . . . . crossbreed here, and crossbreed there, until the specific potential is broken down and strange and unlooked for variations are born and grown up irrespective of strange and abnormal surroundings. From these congenital variations they select the desired forms, and perpetuate them with perfect assurance and security." A good example of what can be accomplished in this manner by biparental reproduction is the result of some hundred years' work upon the rose. From a comparatively few wild forms, many thousands of cultivated species and varieties have been produced. Chapters upon "Regression" and the causes of "Spontaneous Variation" conclude this section of the work, and chapters upon the "Evolution against Disease," "Narcotics," "Automatic and Voluntary Action," "the Mind of Man," Methods of Religious and Scholastic Teaching," and other subjects treated from an evolutionary point of view, occupy the remainder of the volume.

In a work of this character, extending over a wide field of knowledge, one naturally finds statements which invite criticism. Mr. Reid may, however, be congratulated upon having contributed a work to the literature of evolution in which he has approached the subject from a new point of view, and which contains much that deserves careful attention.

* *Nature*, November 29, 1894.

The Tutorial Chemistry.—Parts I. and II., by G. H. Bailey, D.Sc., &c. Second edition (University Tutorial Press), 3s. 6d. each part. This work, first issued some ten years ago, has already earned a good reputation, but modern progress, with its reforms in the methods of chemical teaching, has demanded that it should be brought up to date. The main features of the work have been retained, but Part I. (non-metals) now contains two distinct sections. Of these, section I. consists of an introductory course based on a series of simple experiments and designed to illustrate the leading laws and principles of the science and to train the student as early as possible in "scientific method." Section II. contains a systematic treatment of the non-metals illustrated by numerous instructive and typical experiments; the proofs of composition and constitution form a special feature, and in the case of each important substance some account is given of its history and the purpose for which it is employed. Part II. (metals) also consists of two sections, section I. being an account of physical chemistry, which has been here brought completely up to date. Section II. is a full account of the metals; the chemistry of radium, electro-chemical methods for extraction of metals, the determination of atomic weights, and many other matters of interest depending upon recent researches and discoveries have received special attention. The book, as it now stands, gives a complete account of chemistry as usually studied for University final degree examinations. For intermediate science students of London University who wish to keep closely to its syllabus, asterisks have been placed to those paragraphs which do not fall strictly within the scope of the examination. There are one or two instances in which one might have expected the book to be rather more up-to-date. For instance, very little is said about calcium or the new method of obtaining it. The new alloy "Invar" is not referred to by name, nor can we find any allusion to the recently discovered magnetic alloy of copper and manganese.

Modern Industrial Progress, by Charles H. Cochrane (Lippincott Co.), price 10s. 6d., is really a very fascinating book. It is not by any means a scientifically accurate account of this exhaustive subject, but the story is well told, the illustrations profuse and alluring (if not always very correct), and the matter abundant and of great variety. We are told of electric generators and X-rays, of electric trains and "converters," of wireless telegraphy, of steel manufacture and the treatment of ores, of aërial navigation and kites. Evolutions in vehicles and roadways, in ships, and in tools of destruction are described, as are canals and tunnels, timber getting and working, mining, food, and water. Engineering enterprises of all sorts are gone into, and, in fact, to give even a list of the matters which are here attractively described would fill more space than we can devote to it. What is here told must be taken with—well, a milligramme—of salt, but this minute saline admixture does not detract from its forming a very readable and even instructive book.

N-Rays: A collection of Papers communicated to the Academy of Sciences, by R. Blondlot; translated by J. Garcin (Longmans, Green and Co.; price 3s. 6d. net).—Professor Blondlot has experienced in his efforts to make known the N-rays the truth of the maxim that the way of the scientific discoverer is hard; and though other theorists before him have had to battle quite as hard for their theories, it is doubtful whether the scepticism expressed about the reality of the phenomena he has observed has ever been quite of the same kind. One might say that the sceptics, except in France, still outnumbered the disciples, and that the proselytes were few in number. But in a case of this kind one piece of affirmative testimony must outweigh a great deal of negative evidence, and M. Blondlot's critics are divided among themselves, some maintaining that the alterations which the hypothetical N-rays produce in the luminosity of a testing screen are due to heat, while others say that the alterations do not exist at all. In the domain of affirmative testimony there has lately been added evidence of the greatest importance from Professor Hackett, of Dublin University, who has attained such definite results that he is able to discern, through the aid of

his detector screen, the emission of N-rays from a silent tuning fork; and from Professor Broca, who has examined and distinguished the so-called physiological causes of the rays. We may perhaps sum up the case for the real existence of the rays by a method of questions and answers. Is the change (in the detector screen) due to physical causes proceeding to the screen? If so, then the physical existence of the N-rays, or of something analogous to them, is established. Is the phenomenon due to changes produced within the eye itself? If so, then physiology must explain all the correlated and complicated phenomena which result in terms of optical illusion such as the structure of the eye could produce. Lastly, is the phenomenon due to the mind of the observer? Then, if so, psychology has a task similar to that we have suggested for physiology. If on the contrary all these hypotheses are false, and there is *no* appearance of change in the detector screen; that is to say, if, in other words, M. Blondlot, Professor Charpentier, Professor Hackett, M. Broca, and M. d'Arsonval are united to bear false witness, the whole matter seems one for the alienist, for such a tissue of related and corroborative falsehood was never before recorded. We do not hesitate to say, therefore, that we believe the establishment of the objective reality of the N-rays to be merely a matter of time and careful experiment. This end will be furthered by the translation before us of the extremely straightforward, clear, and workmanlike papers which M. Blondlot has communicated to the Paris Académie des Sciences. Here we have collected his own observations, the gradual process of development of his experiments, and his candid efforts to meet and reply to criticism. No one can pretend to pass judgment without carefully reading this collected series of papers, to which additional value is given by M. Blondlots' directions for preparing the detector screens. A screen of the kind is furnished as a frontispiece to the work; and we cannot do better in taking leave of it than to quote M. Blondlot's warning as to the method of observation of N-rays: "It is *indispensable* in these experiments to avoid all strain on the eye, all effort, whether visual or for eye accommodation, and in no way to try to fix the eye upon the luminous source whose variations in glow one wishes to ascertain. . . In fact, the observer should accustom himself to look at the screen just as a painter would look at a landscape. To attain this requires some practice, and is not an easy task. Some people, in fact, never succeed."

On False Education, by Frederick Hovenden, F.L.S., F.C.S., F.R.M.S. (Watts; price 3d).—It is perhaps invigorating and salutary occasionally to read attempts to upset and prove illusory one's deeply-imbibed dogmas, or at all events to hear them investigated, dissected, and criticised. We have been brought up to believe in mathematics as a subject deserving of our highest respect; infallible, conclusive, beyond argument. Yet here we are suddenly confronted with an assertion that the whole thing is a mockery and a delusion! Arithmetic exists: two and two still make four. Multiplication is but addition repeated; two and two and two, that is, two added three times over, make six. But according to this author, 2×3 is not at all the same as 3×2. Algebra is delusive; $2a \times 3b$ is nonsense; as well say multiply two apples by three pears! All this starts one thinking. Where are we?

What Do We Know Concerning Electricity? by A. Zimmern, B.Sc. Pp. 140. (Methuen and Co., London; 1s. 6d. net).—This is a delightful elementary account of electrical phenomena intended for readers who may wish to obtain some knowledge of the subject, and who "yet may not have the desire or opportunity to make a thorough study of the subject." The aim of the author will certainly be fulfilled. Simple though the language is, it seems to be wonderfully accurate; and throughout a style which approaches distinction is maintained. The following extracts which refer to different questions will illustrate the author's cautious attitude: "The pictorial representation of the processes of electrolysis which scientists now adopt as a 'working hypothesis' is this'" "The modern conception of an ether is an invention due to Huyghens. I use the word invention advisedly because we have no experimental evidence for its existence. . . . Yet . . . there is a great and increasing amount of circumstantial evidence for the existence of *something* of which the ether as we conceive it is the expression suited to our present knowledge." This is excellent. We leave the book with regret that we have not referred to the chapters on the passage of electricity through gases and on radio-activity.

Bacteriology.—A Laboratory Guide in Elementary Bacteriology, by William Dodge Frost, Ph.D. Third edition (Macmillan; price, 7s. net).—If one wished to review Dr. Frost's guide to the bacteriological student in the shortest possible number of words, one would say that it was exactly what it professes to be in its title. It details for the student the exact methods that he will have to follow in the bacteriological laboratory in order to obtain a thorough working knowledge of the science, and to fit him for more extended research. It is arranged with two ideas in view; the first, and perhaps the more important, to indicate the experiments which a student will have to make and the best way of making them—and in this respect the third edition differs from those which have preceded it by substituting new and improved methods of established examinations of bacterial cultures; and, the second, the best order in which to take these experiments. Thus we proceed from the making of bouillon for cultures to the inoculation of animals and the bacteriological examination for human autopsies. The second subdivisional arrangement of Dr. Frost's volume is that which suggests the study of the various bacteria in groups, the most logical and reasonable method, and the one which is most in keeping with recent tendencies. It is a most valuable and practical manual.

Sociology.—Sociological Papers, by Francis Galton, E. Westermarck, P. Geddes, E. Durkheim, Harold Mann, V. V. Branford, and James Bryce. (Published for the Sociological Society: Macmillan).—The contents of this volume consist principally of the papers read before the Sociological Society last year, and amid a mass of interesting material, the essay by which Dr. Francis Galton strove to establish the new science of "Eugenics" is, perhaps, the most important. Dr. Galton's idea is that we may establish the coming race, sound in wind and limb, in mind, and in morals, by selective breeding. It is a hypothesis which we believe to be vitiated by the fact that we do not know what to breed for; that it is not the fittest that survives, but the more fit; and short of exterminating the unfit at birth, a proceeding to which mankind still entertains a sentimental objection, we do not think any method of artificially improving the births of the world would effect much. More entertaining, however, is Dr. Galton's effort to remedy a noticeable omission in the annals of talent. We have many biographies of great persons, but no collection of biographies of gifted families; and since it is probable that brain is as much a heritage as bone or muscle, it is as well for those who wish to improve the race to know how far and in what directions the cleverness of a parent is transmitted or inherited. Dr. Galton's way was to send a letter to Fellows of the Royal Society asking them to give particulars of the noteworthy achievements of their near relatives; and from the 250 replies received, he arrived at the general conclusion that ability as measured by achievement tended to be a family characteristic in a marked degree. Achievement as a rule was measured by mention in the "Dictionary of National Biography," in the "Encyclopædia Britannica," and in a lesser degree in "Who's Who?" but besides families distinguished in this way, there were others whose members were reputed to have a high level of ability. We each of us have on an average ten near male relatives who live long enough to attain distinction if they have it in them—two grandfathers, one father, two uncles, one brother, and four first cousins. Usually distinction is sufficiently rare to make it probable that if one of these ten reaches Dr. Galton's standards of distinction, there is genius in the family; but Dr. Galton's statistics show that where Fellows of the Royal Society are concerned there is the average of no fewer than four distinguished persons in the ten. Some of the family trees are so remarkable as to be worthy of special notice—that of the Darwins, for instance. Charles Darwin was the grandson of Erasmus Darwin, F.R.S., physician, poet, and philosopher; and of Josiah Wedgwood, F.R.S. He was the son of Robert Darwin, F.R.S., a distinguished physician; and was the nephew of Charles Darwin, who had a career of extraordinary promise. He was, of course, related to other descendants of Josiah Wedgwood, and to the Galton family among them. Of his four sons, Francis, George, and Horace are all Fellows of the Royal Society, and Leonard Darwin is a brilliant scientific Engineer officer. Similarly, the Horsleys are related to the Hadens, the Brunels, and the Bramwells.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The selection of a printing process.—In scientific work one is often satisfied with the production of the negative, and sometimes rightly so, but for demonstration, reproduction with letterpress, storing for convenient reference, and in other cases, it may be desirable, if not necessary, to make prints. In one sense a print must always be inferior to the negative because it is a stage further from the original, but it may be practically far superior because it gives the photographer further opportunity for making more conspicuous the very matter that he wishes to investigate or demonstrate. In the choice of a printing process there are more possibilities than are generally recognised.

There are now to be obtained silver printing-out papers specially prepared for giving vigorous prints from poor and flat negatives, and by the use of them important detail in a photo-micrograph or a spectrum photograph that is feebly represented in the negative may be made much more conspicuous. Among development papers, slow bromide or "gas-light" papers are specially suitable for this purpose. A smooth surface should always be selected, and if it is made more shiny still by drying it on a sheet of ebonite (or glass or ferrotype iron), the detail will show still more markedly. It may be that in a print so obtained much of the other parts of the subject will be lost in obscurity, but then it is easy to prepare another print on an ordinary paper, making the best of the subject as a whole, and to show this with the special print of the particular part that needs emphasis.

If it is desired to show the general characters of a subject without special emphasis of detail, as may be the case with photographs of some geological subjects, a rougher surfaced print is an advantage. A matt-surfaced bromide print, or a print on a paper that has no layer of medium on it (gelatine or albumen), such as platinotype paper and some silver papers, will serve this purpose. Here the detail will not be lost, but it will be less obtrusive.

If permanency is the chief desideratum, there are three processes that specially come to mind, namely, platinum and carbon printing, and the production of enamels. Of these, undoubtedly the most convenient for those who do not make a business of photography is printing in platinum, and, although it is making rather a fine distinction to compare the probable lasting properties of these three kinds of photographs, I think that a platinum print would probably out-live the others. If it were my duty to prepare photographic records for the express purpose of being in usable condition a thousand years hence, I should be inclined to prepare prints by these three processes, unless the subject was too large for making an enamelled plate from it, and then I should not much regret having to rely on the other two. But if I omitted to prepare platinum prints, I should feel that I had not been faithful to my trust. If a platinum print is not brilliant enough to clearly show the detail to which attention is to be directed, it may be waxed, a process that used to be in vogue years ago in connection with silver prints, but is rarely used now. For this purpose white wax is melted with turpentine in such proportion that the mixture, when cold, is of the consistency of a thin pomatum. This is applied to the surface of the mounted print by means of a small flannel pad with a light polishing movement similar to that adopted when "French polishing" wood-work.

Gelatine v. Collodion, etc.—It has sometimes been deplored, for the sake of experimental rather than practical photography, that collodion has given place to gelatine as the vehicle of the sensitive salt. Gelatine is supposed to be complex, variable, and uncertain, and no doubt it justifies its reputation, but whether the collodion film is either more simple, stable, and reliable is open to considerable doubt. Those who have stored both gelatine and soluble guncotton will know that the former appears to remain unchanged indefinitely, while the latter cannot be preserved in a glass bottle for very long, because of the continual evolution of acid vapours that must be allowed to escape, and that if stored as is usual in paper lined tin canisters or cardboard boxes, the paper gets rotten and the tin corroded. It is too often taken for granted that guncotton is merely cellulose nitrate, and that the sulphuric acid used with the nitric acid in its preparation merely facilitates the action of the nitric acid on the cotton, perhaps chiefly by its dehydrating action. But it has long been known that sulphuric acid has a specific action of its own upon cotton, and Messrs. Napier Hake and R. J. Lewis have recently shown (*Jnl. Soc. Chem. Ind.*, 29th April, 1905) that cellulose sulphates are generally, and probably always, formed in small quantities in the preparation of guncotton, and that they often, if they do not always, remain in the finished product, and are an element of instability. This investigation refers to the guncotton of warfare, and photographers who refer to the paper should bear in mind that soluble guncotton or pyroxyline is prepared with far less care than the other.

Experimentalists who want a pure sensitive film free from the uncertainties of either gelatine or collodion have sometimes regarded the daguerreotype process as very advantageous. But even here there are uncertainties, for General Waterhouse has shown that an ordinary clean silver surface is sensitive to light, while if thoroughly cleaned by heating and treatment with acid it becomes insensitive. These is little doubt that whatever support or medium is used for the sensitive salt, its character must be taken into account in investigational work, and that none of those hitherto shown to be available can be regarded as inert. But this is no justification of the extreme view that has sometimes been expressed to the effect that the sensitive substance in ordinary plates is not silver bromide, but a product of the action or combination that has taken place between it and the gelatine.

Radiation or Emanation.—The fact that many substances give off something, whether a radiation or a gaseous emanation, that produces the developable condition in gelatino-bromide plates is being gradually extended. The latest additions to the list of "active" substances are mercuric cyanide, mercuric chloride, a few other mercury salts, and a compound of mercuric cyanide with phenylhydrazine. Metallic mercury was found to be quite inactive, as Dr. Russell stated it to be some years ago. Messrs. R. de J. F. Struthers and J. E. Marsh have obtained these results, and further details concerning them will be found in their paper published in the *Journal of the Chemical Society* for April (p. 377).

We regret that the word actinism in two places in the May issue appeared spelt activism—contrary to author's copy.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Photo-Micrography with Ultra-Violet Light.

The resolution of a microscope objective is determined by its aperture, and though the use of immersion objectives has enabled us to increase the latter, and, consequently, the former also, to an extent undreamt of in the days when we were limited to the use of lenses used dry, a suitable all round medium has not yet been discovered which will satisfactorily replace cedar oil and so enable objectives to be made of still greater aperture. True, an immersion lens has been made which is used with mono-bromide of naphthalene, and which has a proportionately greater aperture even than those used with cedar oil, and, therefore, greater powers of resolution, but this medium is, unfortunately, not a suitable mounting medium for most objects, so that the lens is but little used. Without entering into the diffraction theory, it may be stated that with an objective of given aperture—say 1.4 N.A., which is approximately our present practical limit—we can only increase the resolution by reducing the *velocity* of the light by which we illuminate the object—that is, by increasing the refractive index of the medium in which the object is mounted—for example, when it is mounted in realgar, or by using light of *shorter wave-length.* The first method has, of course, its limits as already mentioned, but there remains the second. Now, it is well known that white light is made up of rays of different refrangibility, and, accordingly, of different wave-lengths, of which those at the red end of the spectrum are the longest, and those at the violet end the shortest. Therefore, mono-chromatic light, selected by means of a prism or screen, and taken from the blue, or, still better, the violet end of the spectrum, will give us greater resolution than ordinary white light which combines so many rays of longer wave-lengths. This fact is taken advantage of in photography, and the result is a very definite increase in resolution, say, of the markings of a difficult diatom. When violet light is used the eye is, unfortunately, little sensitive to these rays, so that it is not easy to see the object, and though such light has high actinic value, it is difficult to focus the object satisfactorily when it is used. Dr. Kohler, of Jena, has, therefore, experimented with ultra-violet rays, which are invisible, but can be used for photography, and their still shorter wave-length, 275 $\mu\mu$, has proportionately greater resolving powers. The lenses are made of crystal and fused quartz, and as mono-chromatic light is to be used, they need correction only for spherical and not for chromatic aberration. The light is obtained from electricity passing between cadmium electrodes. But the human eye, as we know and have just stated, cannot see these rays, and so cannot focus and adjust them. Therefore, Dr. Kohler has devised what may be called an artificial eye; in other words, he constructs what corresponds to an eye-lens, made of crystal, and a retina made of fluorescent glass, which responds to these ultra-violet rays. The image on this "retina" is examined visually by means of a lens, in which case Dr. Kohler has found magnesium light, of wave-length 280 $\mu\mu$, better than the cadmium light. The fluorescent light, however, is, unfortunately, harmful to the eye, and, apart from this, the best results are given by photography. The objects, mostly organic tissues, have been so far mounted in dilute glycerine or in salt solution, and structure has been made evident, which, before, required staining to bring out, more especially because of the comparative impermeability of certain structures, such as the horny layer of the skin, and plant membranes. The lens and its adjuncts were made by the firm of Zeiss, and has recently been exhibited at the Natural Science Club in Cambridge. It may have considerable possibilities.

Royal Microscopical Society.

April 19, at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., President, in the chair. The Secretary read a description of an old portable microscope made by W. and S. Jones, which was said to have been the pocket microscope of Dr. Jenner. Mr. W. J. Dibdin exhibited a slide of *Bacillus typhosus*, and explained the method adopted in staining and mounting. He also exhibited photo-micrographs of the slide at magnifications of 2,500 and 5,000 diameters, with the flagella well displayed. Mr. A. E. Conrady gave a *résumé* of his paper, "On the Application of the Undulatory Theory to Optical Problems," illustrated by diagrams shown upon the screen. Dr. Spitta said that in using the method of graphical representation, Mr. Conrady rendered the subject intelligible to most people, and inquired if the method of explaining the subject originated with the author, as he did not remember having seen it in any of the text-books. Mr. Conrady said the method was not devised by himself, but would be found in the article on the Wave Theory, by Lord Rayleigh, in the "Encyclopædia Britannica."

Quekett Club Journal.

The half-yearly issue of this Journal contains rather less matter than usual. It appears from the Annual Report that owing to an increase of rental it was found necessary to economise in the Journal by shortening the reports of meetings—which is probably not much loss—and in omitting the reviews of books, which were a useful feature. However, I am glad to see that the membership has considerably increased during the past year, and that the finances of the Club are in a satisfactory condition. The Journal contains Dr. Spitta's address on "Improvements in Modern Objectives," a translation by Mr. Rheinberg of Prof. Ambronn's review of Prof. Abbe's work, and other papers and notes.

Watson-Conrady Photo-Micrographic Apparatus.

Mr. A. E. Conrady has computed for Messrs. W. Watson and Sons an entirely new system of lenses for photo-micrography, which I have found to give better results than any other apparatus which has come under my notice. It is mounted in the modern way on an optical bench, by means of which each part is capable of ready adjustment whilst keeping in exact alignment, centring screws being provided for the preliminary adjustments. Taking the parts in order we have first a source of illumination. This may be by arc light or by oxy-hydrogen jet, mechanical adjustments, both vertically and horizontally, being provided, and the whole enclosed

in a Russian iron case. The usual large condenser of two simple plano-convex lenses is replaced by an achromatic and aplanatic doublet about $2\frac{1}{4}$ ins. diameter, which projects a sharp, enlarged, aërial image of the source of light. The corrections of this condenser are of an unusually high order. Condensers of four inches or more have generally been considered essential, but a little consideration will show that no microscopical apparatus can utilize a cone of light of so large an angular extent, whilst the spherical aberration of all but the innermost zone of such uncorrected condensers is so considerable as to render the greater portion of these lenses quite useless for practical purposes. Thus the small but really aplanatic condenser yields a brighter illumination than could otherwise be utilized, because losses by absorption and reflection are reduced to a minimum, whilst those due to spherical aberration are entirely done away with. In fact, the clear diameter even of this condenser is too large for most microscopical purposes, and an iris diaphragm is therefore provided close to the lens so that its aperture may be reduced to any desired extent. The condenser is so adjusted as to project an aërial image of the source of illumination from 10 to 15 ins. away from the microscope stage—*i.e.*, at a suitable distance from the sub-stage condenser of the microscope. In the plane of this aërial image is provided a second iris diaphragm, by means of which the flame image can, if necessary, be reduced to such a size as will just cover the amount of object that is to be photographed. This second iris diaphragm also materially assists in diminishing internal reflections in the microscope tube. A thin auxiliary lens is provided as an accessory which, when placed close to the intermediate diaphragm, forms an image of the large condenser on the iris of the second condenser, thus collecting all the light passing through the latter, and filling even large sub-stage condensers with light. For low powers the large aplanatic condenser alone can be adjusted so as to project an image of the source of light on the diaphragm of the lens in use, thus evenly illuminating objects two inches or more in diameter. The usual cooling trough is provided. I have been using this apparatus for some time and have found that the necessary adjustments are very readily made by means of the iris diaphragms, and that once made they require but little subsequent alteration; in fact, it is only a matter of a few minutes to remove the microscope from the table where one is working and to place it in position for photography, with the knowledge that very simple adjustments will give perfect optical results. The condenser not only gives unusually perfect illumination, but very considerably reduces the necessary exposure. I do not, of course, mean to imply by this that successful photo-micrography is merely a question of optical adjustment and exposure.

Notes and Queries.

J. E. Blomfield (*Sevenoaks*).—I am afraid you will not find anyone who lays himself out to supply the rarer fresh-water algæ. I have made inquiries here and cannot hear of any such person. An advertisement might be of use. Do you know Prof. G. S. West's "British Fresh-Water Algæ"?—it contains useful hints as to collecting.

John Hume (*Newcastle-on-Tyne*).—Soft sections want very careful dehydrating and clearing. The alcohols must be carefully proportioned, as 30 per cent., 50 per cent., 75 per cent., and 95 per cent., and the section should stay a good time in each bath. It would be best to clear in xylol and mount in xylol-balsam, and it would be advisable to have an intermediate bath of half xylol and half alcohol between the 95 per cent. alcohol and the xylol. Perhaps also your sections are too thick, in which case they do not get properly permeated with the media and shrinking at one stage or another is very likely to happen. Benzine and benzole are different names for the same substance. Sections preserved in alcohol cannot be stained with carmine or hæmatoxylin made up as watery stains—alcoholic solutions must be used. Probably your trouble is due to your overlooking this fact. Eau de Javelle is practically hypochlorite of potash, and in using it you are putting back into the section the water which the alcohol had removed, alcohol being essentially a dehydrating agent. Sections stained with a watery solution of hæmatoxylin should mount well in glycerine jelly if properly stained. After staining, they should be washed in tap water, not distilled water. This deepens and fixes the colour, owing to the calcium salts it contains.

N. L. Gillespie (*Fulham*).—Slides for sending abroad are best packed in the little wooden boxes which can be obtained from the opticians, fitted with upright racks. They are very cheap. Each slide should have its edges well packed into the rack with cotton wool. A good way, however, is to fold a strip of paper of suitable length into a strip one inch wide, so that it contains several thicknesses of paper, and then fold two such strips in and out between the ends of the slides, one strip at each end, in in such a way that a double tongue of the strip lies between the ends of each slide, projects inwards for about an inch (not reaching the mount), and so separates it from those immediately above and below. The nest of slides is then tied tightly round with string and carefully packed in any handy box. Care must, of course, be taken that the last slide of the nest has its mount turned inwards for protection like the others.

J. Cooper (*Wigan*).—The best pocket lenses are those made on the Steinheil principle. They are aplanatic—which means flat in the field right up to the margin of the lens—and achromatic, or free from colour. They are of brilliant definition and a great comfort to the eyes. Such lenses are known as aplanatic pocket lenses, and are made by all the leading microscope makers (see the advertisement columns of this Journal) and there is little to choose between them. They cost from 12s. to 15s. each, and the powers run 6, 10, 15, and 20, or thereabouts. I think 6 is the handiest size, and certainly it is the most comfortable to use; the higher powers are very tiring to the eyes. The lens should be mounted for the pocket.

J. Strachan (*Ballyclare*).—With reference to my recent article on the Fibrous Constituents of Paper I must confess that I have never found any quantitative method of estimating the percentages of various fibres to be trustworthy, except in a very rough and ready way. Your method of counting the various fibres is probably the best and is accurate within its limits, but is very laborious; and I am afraid I must ask you to forgive me if I am not able to check your results as my time is very fully taken up with work of many kinds. If you will be good enough to send on the samples of chemical wood pulp and mechanical wood pulp, which you kindly offer, I shall be glad to accept them on behalf of my readers, and to distribute them to any who care to apply, provided they will enclose a stamped addressed envelope for the purpose.

A. H. Glaister (*Darlington*).—Your method of marking the actual magnification on the negative of a photo-micrograph has been often used, but I am obliged to you for your communication; and as some of my readers may not know of it, I will give the method herewith as emanating from you. Briefly, it consists in first taking a photo-micrograph and then, without altering the adjustments of camera-length, tube-length, eyepiece or objective in any way, of replacing the dark-slide by ground-glass, and projecting thereon the lines of an ordinary stage micrometer. The distance between the lines is then marked on the edge of a slip of paper, and this is used as a template, by which the marks can be scratched across the negative at the side of the photograph. The value of the lines is added, and the whole reproduces on the positive as part of the photograph.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St Barnabas Road, Cambridge*.]

The Face of the Sky for June.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 3.52, and sets at 8.4; on the 30th he rises at 3.48, and sets at 8.18.

Summer commences on the 22nd, when the Sun enters the sign of Cancer at 3 a.m.; on this, the longest day, he rises at 3.45 and sets at 8.18.

The equation of time is only 6 seconds on the 14th and 15th, hence these are suitable dates for adjusting sundials by the clock, as correction for longitude need only be applied.

The solar cycle is approaching a maximum, and sunspots may be observed on any clear day, whilst spectroscopic observations of the Sun's limb have, of late, shown many fine prominences.

The position of the Sun's axis and equator, required for locating the spots, is as follows:—

Date.	Axis inclined from N. point.	Equator N. or S. of Centre of disc.
June 1 ..	15° 33′ W.	0° 28′ N.
„ 10 ..	11° 59′ W.	0° 37′ S.
„ 20 ..	7° 41′ W.	1° 49′ S.
„ 30 ..	3 10 W	2° 57′ S.

The Moon:—

Date.	Phases.	H. M.
June 3 ..	● New Moon	5 57 a.m.
„ 10 ..	☽ First Quarter	1 5 p.m.
„ 17 ..	○ Full Moon	5 52 a.m.
„ 24 ..	☾ Last Quarter	7 46 p.m.
June 14 ..	Perigee 227,500 miles.	1 0 a.m.
„ 25 ..	Apogee 251,200 „	11 48 p.m.

Occultations.—The only occultations occurring before midnight are as follows:—

Date.	Star's Name.	Magnitude	Disappearance.	Reappearance.
June 12 ..	ρ¹ Virginis	6.1	7 56 p.m.	8.41 p.m.
„ 12 ..	ρ² Virginis	4.9	8.22 p.m.	9.24 p.m.
„ 20 ..	29 Capricorni	5.5	(Star below horizon.)	10.52 p.m.

The Planets.—Mercury is a morning star during the former part of the month, and is in superior conjunction with the Sun on the 24th. Throughout the month the planet is not well placed for observation.

Venus is a conspicuous object in the early morning sky, rising about 2 a.m. near the middle of the month. The planet is at greatest brilliancy on the 2nd.

Mars comes to the meridian at an altitude of 23° shortly before 9 p.m. on the 15th, and is situated near the double star α Libræ; he is readily distinguished by his brightness and ruddy colour. The diameter of the planet is 16′; the disc as seen through the telescope appearing slightly gibbous with dark markings in the southern hemisphere. The northern hemisphere of the planet is inclined towards the earth, but the snow cap is scarcely discernible, as the season of this hemisphere on Mars corresponds to our early September. The planet is at the stationary point on the 18th, after which his motion is direct or easterly; on the evening of the 13th the Moon is 6° N. of the planet.

Jupiter is a morning star in Aries, rising at 2.0 a.m. on the 19th.

Saturn is a morning star in Aquarius, rising shortly before midnight near the middle of the month. The planet is stationary on the 14th.

Uranus is in opposition to the Sun on the 24th, hence about this date he is on the meridian near midnight, but, on account of his great southerly declination, he only attains a meridian altitude of 15°. The planet is situated about midway between the stars μ and λ Sagittarii, and although just perceptible to the naked eye, is readily found with slight optical aid.

Neptune is in conjunction with the Sun on the 30th, and consequently is unobservable.

Meteor Showers:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
June—July	17 16	−21	α Scorpiids	Fireballs.
June 13	20 40	+61	α Cepheids	Streaks, swift.

Double Stars.—α Libræ, XIV.h 46m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

β Scorpii, XVI.h 0m, S. 19° 33′, mags. 2·7, 5·2; separation 13″·1.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

The International Ornithological Congress.

The fourth meeting of the International Ornithological Congress, under the Presidency of Dr. R. Bowdler Sharpe, will take place in June at the Imperial Institute, South Kensington. H.R.H. the Prince of Wales, K.G., has graciously accepted the post of Patron. The General Committee contains the names of many of the best-known ornithologists throughout the world who are likely to be able to attend the meeting.

The first meeting of the Congress will be held on Monday, June 12, at 9 p.m., when there will be an informal reception at the Imperial Institute. A General Meeting will take place next day at 10 a.m., and the five Sections (Systematic Ornithology, Migration, Biology, Economic Ornithology, and Aviculture) will assemble at 3 p.m. on that day. The Sections will meet again at 10 a.m. and 3 p.m. on Wednesday, June 14, and in the evening of that day there will be a conversazione at the Natural History Museum. Thursday, June 15, will be devoted to an excursion to the Zoological Museum at Tring, where the Members will be the guests of the Hon. Walter Rothschild, M.P. On Friday, June 16, there will be a General Meeting of the Congress at 10 a.m. In the afternoon the Lord Mayor of London will receive the ornithologists at the Mansion House, and in the evening the British Ornithologists' Union will entertain them at dinner. On Saturday, June 17, the Sections will meet in the morning (10 a.m.), and the concluding General Meeting will take place in the afternoon of the same day.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

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CONTENTS.—See Page VII.

Our Stellar Universe.

By T. E. HEATH.

It is related by Campbell that Sir William Herschel told him he had observed stars the light of which must take two million years to reach this earth. Did Herschel grasp what this meant? It is supposed his reflector could show stars to the 15th magnitude; if so, he might have seen a star the light of which had been travelling for two million years, provided it gave 438,000 times as much light as our Sun.

Professor Seeliger thinks our Stellar Universe is in shape like a thick lens, and estimates the nearest parts of the Milky Way are about 4,400 light-years distant, and the most remote about 9,700. Other astronomers appear to have very vague ideas as to its limits. Some estimate its probable radius at from 10,000 to 30,000 light-years. Few seem to have checked their conclusions by considering what the sun-power of stars at the supposed boundary would be.

I have drawn a section of our Stellar Universe of the shape which Professor Seeliger's statistics of stellar density seem to require, but I have not adopted his dimensions. The maximum size I think probable in light-years is indicated by circles struck from what appears to be the most likely present position of the Sun. The drawing pretends to no accuracy of stellar distribution, save that I have, very roughly, made the stars congregate about the Galactic Zone and the nebulæ about its poles. So far astronomers are agreed, but for the rest some think the stars thin out, others that they get more numerous towards the boundary. Probably the Milky Way is very much what it appears to be, a congregation of stars, clustering here, separating there; irregular forms and masses such as we see in Spiral Nebulæ; nearer to us in parts, more distant elsewhere, but lying generally in a great circle round us. There seems to be no reason for thinking the thickness is greater than the lateral extension; indeed, the rifts and openings give the opposite impression.

I remember how thirty or forty years ago most of the stars were supposed to be almost infinitely distant, but yet revolved in some mysterious way round Alcyone. No one did more by star-charting and lecturing to change the general opinion about the Visible Universe than Richard Proctor. His equal surface chart of 324,000 stars to about 9th magnitude shows the chief features of the Milky Way and even the wonderful complexity of its interior structure. He says it has on it 1,115 lucid stars, and it covers 9 per cent. of the sky; the gaps in the Milky Way cover 1.6 per cent. and have on them only 20 lucid stars, whilst the remaining 89.4 per cent. of the sky has on it 4,715 lucid stars. He concludes the 640 stars in excess of normal density which we see upon the Milky Way are actually in it. Professor Newcomb has shown that the circle of the Milky Way can be found within 5° of its true position by the clustering of lucid stars alone, and proved that about 70 per cent. of stars up to 6th magnitude and about 140 per cent. up to 7th magnitude, which appear to be on the Milky Way, are in it.

Possibly there are no stars in the Milky Way greater than the 3rd or 4th magnitude, and but few of them; of the 5th there would be more, of the 6th a considerable number, and of the 7th and 8th very many thousands. According to Professor Kapteyn, in any group of 15,000,000 stars, $13\frac{1}{3}$ per cent. would be about one sun-power each, $3\frac{1}{3}$ per cent. would be more, and $83\frac{1}{3}$ per cent. would be less. If this be true, from what we know of the probable number of stars of each magnitude (see Mr. Gore's estimate, "KNOWLEDGE," 1901, page 178), a star of one sun-power at the Milky Way's average distance would appear about the 12th or 13th magnitude.

Assuming the Sun's magnitude is −26.4, I worked out his magnitude at different distances in light-years; they come thus, at 479, 11th magnitude; at 759, 12th; at 1,210, 13th; at 1,910, 14th; at 3,020, 15th; at 4,790, 16th; at 7,590, 17th; at 12,100, 18th; and at 19,100, 19th magnitude.

Now there are very few 18th magnitude stars, and it is doubtful if there are any 19th, but it will be seen that if the Sun were removed to Professor Seeliger's estimated mean distance of the Milky Way (viz., 7,550 light-years), he would be reduced to the 17th magnitude. There may be 20 or 30 per cent. of the Milky Way stars as small as this, but they are certainly nothing like 83 per cent. smaller.

Professor Newcomb writes that "the bluest and most luminous stars are situate mainly in the regions of the Milky Way," but apparently he comes to this conclusion because he thinks the Milky Way begins beyond a distance of 1,300 light-years, and considerations based upon proper motions lead him to place these stars even beyond the sphere of 3,260 light-years.

Proctor thought the Milky Way stars are for the most part small.

It seems not unreasonable to suppose that for any considerable group of stars, such as the Milky Way, we can make the best estimate of probable distance by assuming that none of them are much more luminous than the giants of the same class we have measured, and that they contain a fair proportion of the stars of all sizes we have discovered in the only space sphere at all thoroughly surveyed (that of 15 light-years radius).

In my "Road-Book to the Stars" I asked for corrections and additional data. Mr. Gore kindly sent me the paper on the "Relative Brightness of Stars," which he communicated (January, 1905) to the Royal Astronomical Society. In this he only gives stars for which he thinks the parallaxes are fairly good; those most reliable he marks (*), whereas in my "Road-Book" I gave all the estimates I could collect. So far as Mr. Gore's list goes my distances agree with his; I have now in the list for 1st magnitude stars herewith put (*) to the distances he considers most reliable, and (?) against those he does not give at all. Otherwise the light-years remain as in my book. Mr. Gore has taken the Sun's magnitude as − 26.5, whereas I took it as − 26.4; so that, other things being equal, where he called the relative brightness of a star 1,000, I should call its sun-power 1,095.

Mr. O. R. Walkey also has sent me a long and very interesting account of his method of getting at the Absolute Parallaxes for all the 1st magnitude and some other stars. Only he himself could do justice to his method, but I give his absolute parallaxes and sun-powers. (He takes the Sun's magnitude as − 26.4.) If Canopus is, as he thinks, of 71,880 sun-powers, and if the surface brightness is the same as the Sun's, the Sun might be situate at the centre of Canopus, the earth would revolve about 22 million miles below its surface, and we should find it quite unpleasantly hot.

In the following list I have divided the first magnitude stars into two classes: the first, Orion, type O, Sirian, type I, and Procyon, type I-II. The second, Solar, type II, and Antarean, type III. Parallaxes observed at the Cape are marked C, at Yale, Y. The magnitudes are revised Harvard.

In the Appendix to my "Road-Book to the Stars" I give all the data as to other magnitudes I could collect, but they are too few to enable me to work out, correctly, the average distances and sun-power for each type and magnitude. Estimates may, however, be made from Professor Kapteyn's formula derived from parallactic motions. Professor Newcomb has done this in his book on the "Stars," doubling the distance every two magnitudes, but Mr. O. R. Walkey has corrected his parallaxes by going carefully through Kapteyn's original work. From these corrected parallaxes I have worked out the distance in light-years and the sun-power for each type and magnitude. *The results, if they can be relied upon as averages* (not, of course, for individual stars), *are of great importance.*

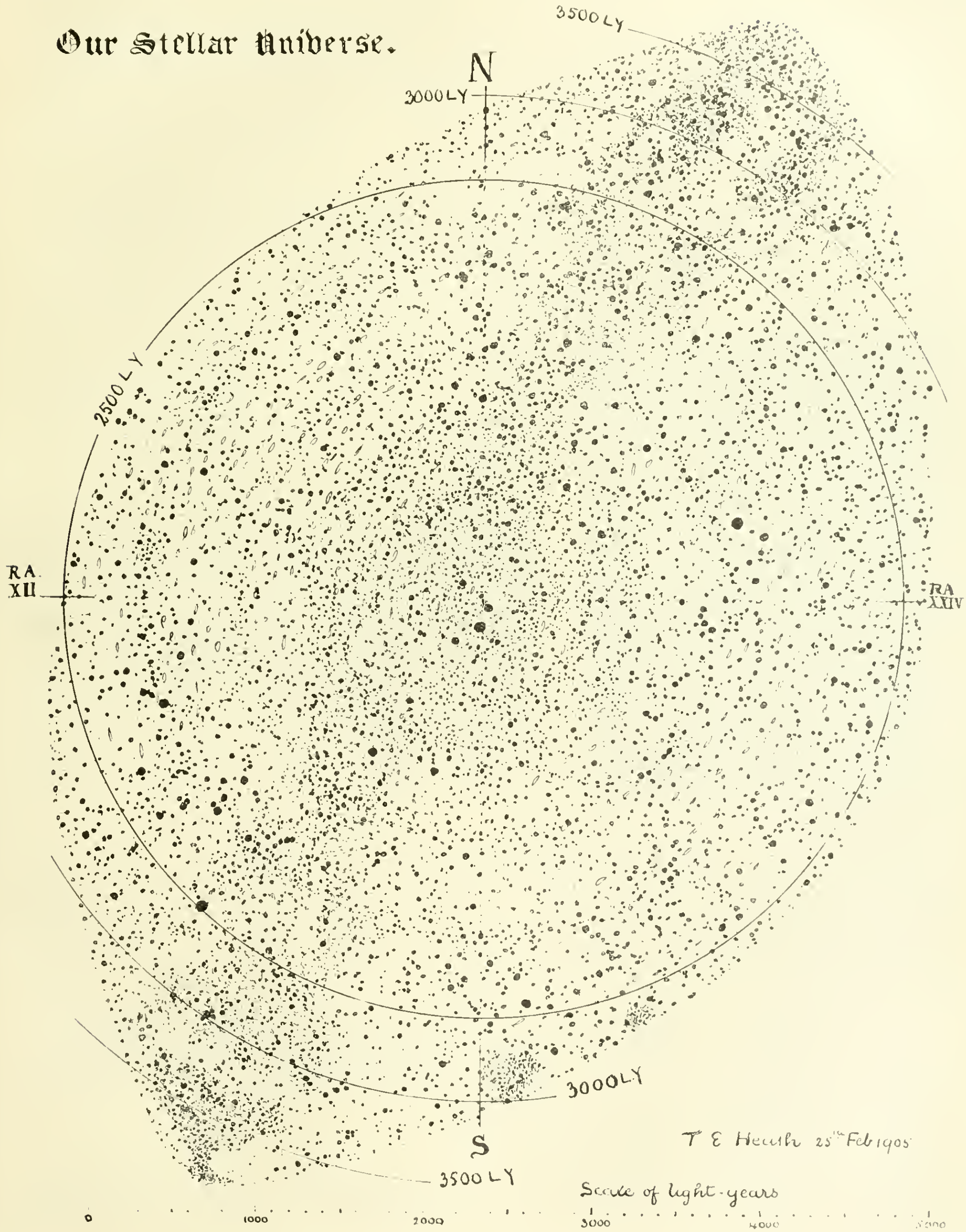
	Type I.			Type II.	
Mag	Light-Years.	Sun-Power.		Light-Years.	Sun Power
2	139	333	...	61	64
3	185	236	...	81	45
4	247	167	...	109	32
5	329	118	...	144	23
6	438	84	...	193	16
7	587	60	...	257	11
8	779	42	...	341	8
9	1041	30	...	457	5·7
10	1392	21	...	609	4
11	1845	15	...	812	2·9

The average sun-power for the first magnitude we have found to be 3,132/8,965 for type I, and 529/397 for type II. Far beyond the second magnitude! From the second down the sun-power is halved every two magnitudes—*the further we go the smaller is the average size!* But in my "New View of the Stars" I show that in the only space-sphere thoroughly surveyed, the percentages are as follows:—24 of 1 to 36 sun-

Star	Type	Magnitude.		Parallax (Relative.)	Error. ±	My "Road-Book." Light-Years.	My "Road-Book." Sun-Power	Mr. Gore's Relative Brightness.	Mr. Walkey's Estimates for Absolute Parallax.	Mr. Walkey's Estimates for Light-Years.	Mr. Walkey's Estimates for Sun-Power.
				"	"				"		
Sirius	I	−1·58	C	·370	·005	8·8	36	33	·377	8·64	35
Canopus	I II	− 0·86	C	·000	·010	? 296	21357	—	·006	543	71880
Vega	I	+ 0·14	Y	·082	·016	39·7	154 a	139	·090	36·2	127
Rigel	O	0·34	C	·000	·010	? 367	11025 a	—	·006	543	23800
Procyon	I II	0·48	Y	·334	·015	10·2	7·6	6·49	·335	9·73	6·7
Achernar	O	0·60	C	·043	·015	? 76	362 a	—	·045	72·4	333
β Centauri	O	0·86	C	·030	·015	? 108	605	—	·036	90·5	410
Altair	I	0·89	Y	·232	·019	14·2	9·6 a	8·79	·239	13·6	9
α Crucis	O	1·05	C	·050	·019	65·2	183	16·6	·044	74	230
Spica	O	1·21	C	·000	·020	? 326	3844 a	—	·010	326	3845
Fomalhaut	I	1·29	C	·130	·014	25	21	18·9	·133	24·5	20
α Cygni	I	1·33	Y	·012	·023	? 271	2565	—	·004	815	21520
Regulus	O	1·34	Y	·024	·020	148	700	642	·031	105	355
β Cruci	O	1·50	C	·000	·008	? 326	2981	—	·010	326	2944
First Class 14 Stars average		0·60		·0219	·015	149	3132		·0153	213	8965
				"	±				"		
α Centauri	II	0·06	C	·752	·010	4·34	1·96	1·79	·757	4·3	1·9
Arcturus	II	0·24	Y	·026	·017	136	1648 a	1486	·034	95·8	950
Capella	II	0·21	Y	·079	·021	40	146	128	·087	37·5	128
At maximum		(0·34)							At maximum		1047
Betelguese	III		Y	·024	·024	? 142	933	—	·029	112	—
		(0·94)									
Aldebaran	II	1·06	Y	·109	·014	* 30·5	39	35	·116	28·1	33
Pollux	II	1·21	Y	·056	·023	? 58	118	—	·066	49·4	88
Antares	III	1·22	C	·021	·012	? 155	820	—	·027	121	533
Second Class 7 Stars average		0·64		·040	·015	81	529		·051	63·7	397

N.B.—Some of my sun-powers marked a are slightly altered from those given before owing to corrected magnitudes.

Our Stellar Universe.



powers, 29 averaging 0.23 sun-powers, 19 averaging .034 sun-powers, and no less than 28 averaging only .005 sun-powers. The majority are dwarfs: it is quite as necessary to provide for dwarfs as for giants in the Milky Way, but there appear to be very few stars of less than the 17th magnitude! The highest authority on this point, the late Dr. Isaac Roberts, writing in "Knowledge" (1901, page 11) about a photograph of the Milky Way, which shows stars down to the 17th magnitude, says, "The evidence of photographs strongly indicates that those vacant places which appear after exposures of 7 to 12 hours are really void of stars, because exposures of only 90 minutes show the same stars down to the faintest magnitudes." His remarks should be read *in extenso*, as they are more conclusive than thus condensed.

To enable my readers to weigh for themselves the value of the evidence given here, in my first article and in my "Road-Book," I worked out a table which gives the sun-power of stars of different magnitudes at different distances. I think it comprehends all the Milky Way stars, but it can be readily extended up or down, or right or left, *e.g.*, 3rd magnitude, at 1,000 light-years = 6,800 sun powers; or 6th magnitude at 100 light-years = 4.37 sun-powers.

From the evidence produced, my readers can judge as well as I—some better—what are the probable dimensions of our Stellar Universe. The first magnitude stars are exceptionally large, and if they only are considered, and if Mr. Walkey's estimates be correct, we might allow a radius of about 5,000 light-years for the Milky Way, but if 80 per cent. of the stars are smaller than the Sun, the radius would not be more than about 1,500 light-years. I have assumed in my drawing the truth lies between these extremes. I claim to be no authirity in such matters, but seek only to illustrate by my diagrams and stereograms such data as I can collect, so that anyone can see what they mean. The scale I discovered, which, taking the Sun's mean distance as one inch, makes the distance travelled by light in one year one mile, is, I find, to most people, a real help. Objects in space of three dimensions can be drawn without distortion as well upon a flat surface as upon a sphere. The excellent maps now being published in "Knowledge" appear to have no distortion if they are viewed with a lens so that the eye is $5\frac{1}{8}$ inches above the centre. It is greatly to be desired that some owner of a clock-driven telescope would take and publish a set of lantern slide star maps (which could be enlarged as required), using a stigmatic lens of $3\frac{1}{4}$ inches focus and short exposure, so as not to go much below the 6th magnitude.

Sun-powers of Stars at Different Distances.

Magnitude of Star.	L.Y. [illegible]	L.Y. 1,500	L.Y. 2,000	L.Y. 2,500	L.Y. 3,000	L.Y. 3,500	L.Y. 4,000	L.Y. 5,000	L.Y. 6,000	L.Y. 7,000	L.Y. 7,500	L.Y. 8,000	L.Y. 9,000
	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.	S.P.
4	2,700	6,080	10,800	16,900	24,300	33,100	43,300	67,600	97,300	132,500	152,900	172,800	218,700
5	1,140	2,550	4,550	7,060	10,200	13,900	18,200	28,200	40,800	55,700	64,000	76,900	91,800
6	437	980	1,750	2,720	3,920	5,330	7,000	10,900	15,700	21,200	24,500	28,000	35,300
7	175	392	700	1,090	1,570	2,130	2,800	4,360	6,280	8,540	9,900	11,200	14,100
8	68	154	272	428	615	840	1,090	1,710	2,460	3,560	3,840	4,360	5,530
9	27	60	108	169	243	330	433	676	973	1,325	1,529	1,728	2,187
10	11·4	25·5	45·5	70	102	139	182	282	408	557	640	769	918
11	4·4	9·8	17·5	27	39	53	70	109	157	212	245	280	353
12	1·7	3·9	7·0	11	16	21	28	44	63	85	99	112	141
13	0·7	1·5	2·7	4·3	6	8	11	17	25	36	38	43	55
14	0·27	0·6	1·08	1·7	2·4	3·3	4·3	6·8	10	13	15	17	22
15	0·11	0·25	0·45	0·7	1·02	1·4	1·8	2·8	4·1	5·6	6·4	7·7	9·2
16	0·04	0·10	0·17	0·27	0·39	0·5	0·7	1·1	1·6	2·1	2·4	2·8	3·5
17	0·02	0·04	0·07	0·11	0·16	0·21	0·28	0·44	0·63	0·85	1·0	1·1	1·4
18	0·007	0·015	0·027	0·04	0·06	0·08	0·11	0·17	0·25	0·35	0·38	0·4	0·5
19	0·003	0·006	0·011	0·017	0·024	0·033	0·04	0·07	0·10	0·13	0·15	0·17	0·2

Dr. Easton in an interesting article ("Knowledge," 1903, page 154) gives a sample of the Milky Way (ar a [illegible] part of sky). He has estimated magnitudes (from 5.2 to 14) of the 1,761 stars shown therein.

To help our judgment I worked out the sun-powers for these stars, upon the supposition they are either 1,500, or 3,000, or 7,500 light-years distant. They come out as follows:—

Average Mag.		1500 L.Y.		3000 L.Y.		7500 L.Y.
5·2	1 Star	= 2075 S.P.	...	8300 S.P.	...	52,900 S.P.
7·5 =	1 "	= 225 "	...	900 "	...	5,730 "
8·3 =	6 "	= 120 "	...	480 "	...	3,060 "
8·8 =	6 "	= 80 "	...	320 "	...	2,040 "
9·3 =	17 "	= 51 "	...	205 "	...	1,300 "
9·8 =	42 "	= 33 "	...	132 "	...	840 "
10·3 =	61 "	= 20 "	...	81 "	...	516 "
10·8 =	103 "	= 12·5 "	...	50 "	...	318 "
11·3 =	135 "	= 8 "	...	32 "	...	204 "
11·8 =	134 "	= 5 "	...	20 "	...	130 "
12·3 =	141 "	= 3·25 "	...	13 "	...	84 "
12·8 =	188 "	= 2 "	...	8 "	...	51 "
13·3 =	224 "	= 1·25 "	...	5 "	...	32 "
13·8 =	697 "	= 0·75 "	...	3 "	...	20 "

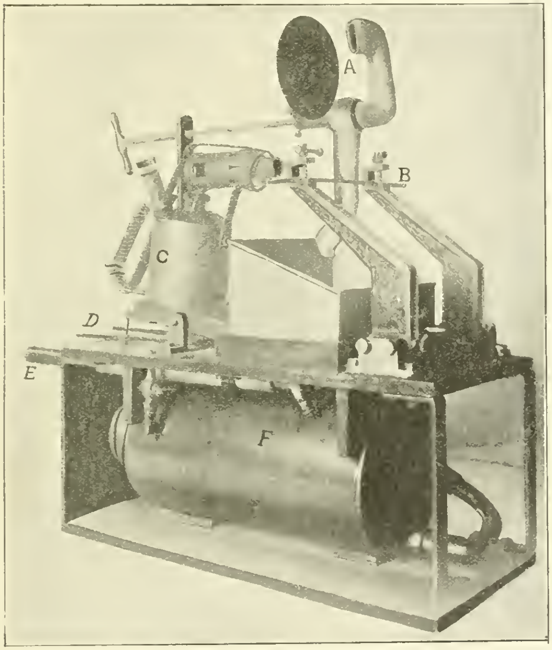
In my first article I suggested a model which would show the Sun and stars of estimated parallax shining with proportionate luminosities. I have constructed such a model more efficiently than I had hoped, and upon convenient flat surfaces, in the six large stereograms I recently exhibited in London. I may even say that when I took the members of three learned societies many hundred billion miles out into space and showed them the Sun and stars shining in their proper colours, with their relative luminosities and hanging in space at their estimated distances, I broke through the crystalline vault which has so long imprisoned even those who know it is but an illusion.

Notice to Readers.

We beg to remind regular subscribers that the Special Number, to be published on July 15th, will run concurrently with the usual numbers, the paging being continuous, and the matter will be included in the index for the year.

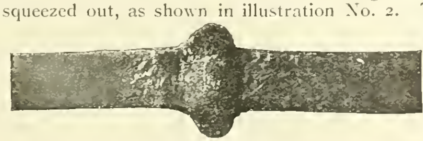
A New Process for Welding Aluminium.

THE Cowper-Coles process for welding aluminium requires no flux, and does not necessitate the hammering of the joint when in the semi-fluid state. The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded, after being faced off square, in a machine (illustration No. 1), fitted with clamping



Cowper-Coles's Machine for Welding Aluminium.
A, Screen; B, Aluminium Rods; C, Lamp; D, Levers for applying pressure; E, Pump; F, Water Reservoir.

screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers D. The aluminium to be welded is heated by means of an ordinary benzine lamp. As soon as the rods have arrived at the necessary temperature, slight pressure is applied to the levers D, which causes the aluminium rods to unite, and a ring of metal is squeezed out, as shown in illustration No. 2. This

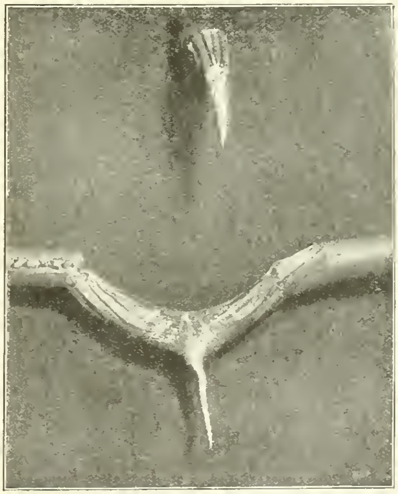


Joint after Welding.

ring is largely composed of aluminium oxide, and acts as an insulating and supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle attached to the screen A, which allows water, under pressure, to be projected on to the joint from the reservoir F. The same handle which turns the water on, places the screen A in front of the heating flame. The water pressure is maintained by air supplied by the hand pump E. The rod is finally removed from the machine and the collar filed off, when it will be found that the joint is as strong as the rest of the metal. An oxygen-hydrogen flame or ordinary gas with or without air can be substituted for the benzine lamp. The process is a simple one, and can be worked by any unskilled workman.

Illustration No. 3 clearly shows the molten aluminium supported by a pipe or case of aluminium oxide, the case having been pricked with a steel point to allow some of the molten metal to flow out.

The following table gives the result of tests for tensile strength on twelve consecutive welds (not picked specimens) made by the process just described. The fractures occurred at a con-



siderable distance from the weld, showing that the metal has not deteriorated at the weld. In the twelve tests referred to, not one specimen broke through the welded portion.

Dimensions.	Area.	Reduction of area at fracture.	Extension.		On Original Area.				Remarks.
			on 4 in.	on 2 in. at fracture.	Elastic Limit (Yield Point). Pounds.	Tons	Maximum stress. Pounds.	Tons	
	Square inches.	Per cent.	Per cent.	Per cent.	Per square in.		Per square in.		
Diam. in.									
0·249	0·0487	7·4	8·0		11491	5·13	20249	9·04	Broke outside datum points.
0·248	0·0483	7·4	13·0		8803	3·93	22265	9·94	Ditto
0·254	0·0507	7·5	8·0		11043	4·93	19868	8·87	Ditto
0·252	0·0499	7·4	11·7		14358	6·41	16150	7·21	Ditto
0·252	0·0499	7·7	13·0		21996	9·82	21996	9·82	Ditto
0.250	0·0491	7·6	9·0		14134	6·31	19622	8·76	Ditto
0·250	0·0491	7·7	9·0		14134	6.31	14134	6·31	Ditto
0·254	0·0507	7·9	11·0		15030	6·71	24304	10·85	Ditto
0·251	0·0495	7·8	7·8		14940	6·67	20361	9·09	Ditto
0·253	0·0503	7·7	14·0		10236	4·57	19152	8·55	Ditto
0·250	0·0491	7·7	9·0		12320	5·50	20070	8·96	Ditto
0·247	0·0479	7·7	9·0		8422	3·76	18704	8·35	Ditto

The Nature of Life.

By GEOFFREY MARTIN, B.Sc. (LOND.).

II.

Now the temperature and pressure on the world's surface have not always remained exactly the same as they are at present. Indeed, it is probable that the further we go back, the higher was the temperature conditions which held upon the world's surface. Probably, indeed, at the earliest times, the world's surface was a white hot fluid mass surrounded by vast masses of vapour. Consequently, in very early times, if living matter existed, its structure must have been quite different to that which it has at present. And the further we go back, the greater must have been the difference between the structure it possessed then and the structure it possesses now. For at ordinary temperatures and pressures, living matter contained the exact quantities of the necessary elements (namely, carbon, hydrogen, nitrogen, oxygen, sulphur, and phosphorus) to make its critical temperature of decomposition coincide with the conditions which hold upon the earth. And as the temperature and pressure of the world altered, the relative quantities of these elements entering into the structure of living matter would also have to alter in order to make its critical temperature and pressure coincide with the new temperatures and pressures.

The higher the temperature and pressure, in general, the greater would be the tendency to let heavier and less volatile elements enter into its structure, and at the highest temperatures and pressures, living matter, if it existed at all, must have been composed out of altogether different elements to those which at the present time enter into its structure.

I would, in fact, suggest that the structure of living matter has, like most other things, undergone a continuous process of evolution (and is still undergoing it) with the changing external conditions, and that at the time when the earth was a white hot fluid sea, life still existed in a form quite different to that which it now possesses; that the chief elements entering into its structure were at that time heavy non-metallic elements, such as silicon, sulphur, phosphorus, and oxygen; and that as the world gradually cooled, the heavier elements were gradually eliminated and the lighter elements took their place by a natural process of circulation, until finally the composition of living matter assumed its present one.

Now is there any element which could play at high temperatures in living matter the part played therein at ordinary temperatures by carbon? Silicon is such an element. Silicon, like carbon, possesses a high and constant valency, has a very considerable capacity for self-combination, and is capable of giving rise to an enormous number of very complex bodies—the silicates and their derivatives—which well vie in complexity with the most intricate carbon compounds. The fundamental difference between the two sets of compounds is essentially one of temperature, the carbon compounds being at ordinary temperatures much nearer their melting and decomposing points than the silicates.

Seeing that the temperature whereat carbon gives rise to protoplasm is at a temperature at which most of its compounds with hydrogen, oxygen, and nitrogen are (probably on account of their instability; see the author's work, "Researches on the Affinities of the Elements," pp. 120-123) in a fluid or semi-fluid state, we should expect that the most suitable temperature for silicon to give rise to an unstable compound would be the temperature whereat the silicates are unstable and, therefore, in a fluid or semi-fluid state—that is to say, at a white heat. Have we any evidence to support the view that living matter did not start originally with carbon, hydrogen, oxygen, and nitrogen as its fundamental elements, but started with elements of far higher atomic weights, such as silicon, phosphorus, sulphur, and oxygen, of which only vestiges now remain in the protoplasm? In this connection it must be remembered that our evidence could be only indirect. For such life might have flourished to an enormous extent in the molten sea of siliceous matter which covered the earth's surface in bygone ages, and yet have left no traces of its existence behind; for when such forms of life died, their bodies would but blend again into the molten rock, in the same way that a jelly-fish dies and blends again into the ocean of salt water, without leaving a vestige behind to show that it has been and gone. Except under exceptional circumstances, organised matter, when dead, very quickly disintegrates.

However, many remarkable siliceous minerals exist—for example, the mineral "Asbestus" or mountain leather—whose peculiar fibre-like structure may be due to its previous organic nature in bygone ages. Again, in some of the most rudimentary forms of organised existence—for examples, the diatoms and sponges—silica still remains in considerable quantities.

Now it is clear that in consequence of the progressive cooling of the earth, the range of temperature at which silicon possesses the capacity for forming the central element of living matter would soon be passed, and hence its complexes would solidify out into stable masses, thus causing all life to cease.

But if carbon entered more and more fully into the composition of living matter, and the silicon as steadily solidified out as the cooling continued, the critical temperature of decomposition (or temperature whereat life is possible) would become progressively lower in proportion as the amount of carbon in the organism increased, and hence the cooling of the surrounding medium, and the alteration in the living temperature of the organism, would proceed together and keep pace—the temperature of the organism lagging slightly behind the falling temperature of the surrounding medium—as it actually does now in world life. The silicon age would thus blend imperceptibly into the carbon age, and when the modern thermal conditions were attained, the carbon would long since have replaced completely the silicon in living matter, and the last era of organic existence would have been entered upon.. I believe that silicon once completely replaced carbon in matter living at a white heat, but that at ordinary temperatures it has been completely replaced by carbon, and remains now merely in certain forms of life as an inactive sediment solely because it can be put to a useful purpose by imparting rigidity to the frame. In cases where it serves no such purpose it has been already completely eliminated; for example, in animal protoplasm only minute traces remain; on the other hand, in grasses and diatoms very large quantities of silicon still exist.

Just as water, the mother liquid in which modern protoplasm first throve, enters to a very large extent into its composition; so also we should expect that

silica of the molten earthy sea would also enter very largely into the composition of the life which flourished at the time when the earth's surface was a red or white hot mass of molten rock. Let me now quote some other facts which make it probable that as the thermal conditions of the earth altered there was a corresponding alteration in the composition of living matter, the denser and less volatile elements steadily solidifying out and their places being filled by analogous lighter and more volatile elements.

Albumen contains a small quantity of loosely-bound sulphur which does not appear to be a very intimate constituent of it. No one knows the function of this sulphur; according to my theory it is simply lingering on, the relics of a time when it almost entirely replaced oxygen in the organism. As the temperature of the living matter fell, the sulphur was superseded by the lighter and more volatile oxygen, and consequently the sulphur which remains is merely an inert mass in the process of elimination, separating out on account of its heaviness, in exactly the same way I have supposed silicon to have separated out in previous ages.

Much the same applies to phosphorus in the tissues of the brain and nerves. It has almost entirely been replaced by the lighter and more mobile nitrogen. The small amount of phosphorus remains mainly because it can perform functions of which nitrogen is incapable. Not only is this so, but traces of a still heavier member of the same group of elements—arsenic—have been recently found in certain animals, where it partially replaces the phosphorus in nucleinic matter.*

In these cases, then, we have a whole chain of chemical analogous elements replacing each other in continually decreasing amounts as they increase in heaviness. Thus :—

Nitrogen	(at wgt. 14)	abundant.
Phosphorus	(at wgt. 31)	less abundant.
Arsenic	(at wgt. 75)	minute traces.

Oxygen	(at wgt. 16)	abundant.
Sulphur	(at wgt. 32)	less abundant.
Selenion	(at wgt. 79)	minute traces, if at all.

Carbon	(at wgt. 12)	abundant.
Silicon	(at wgt. 28)	traces.

These facts favour our supposition that the presence in protoplasm of elements having a high atomic weight are the links which connect the gradually-evolved protoplasm of to-day with the molten minerals of the past. It is very probable, I think, that in many cases formerly abundant elements have ceased to perform any vital function and solely remain as witnesses to the process of evolution, much as the gills on the neck of an embryonic babe bear witness to the aqueous origin of its ancestors. In some cases, perhaps, they are retained on account of the fact that they can be put to useful purposes by being substituted for their lighter chemical analogues, in order to modify the functioning of certain definite organs by reason of certain specific needs. Such would be selenion in place of sulphur; negative sulphur substituted for oxygen; Cu, Zn, or Mn replacing iron; P, As, or even Va itself playing the part of nitrogen in the atomic complexes which make up protoplasm. The whole problem of the secretion of mineral matter by living beings is ably explained by supposing the mobile protoplasm of to-day evolved in a continuous matter from the molten minerals of the past.

By adopting this conception the range of world life would widen magnificently out from the few billion years of Lord Kelvin to countless billions of years, when the world was a white hot globe and its surface a sea of rolling fire. From first principles, indeed, it is very improbable that life could exist only within such narrow limits of temperature and pressure such as are at present prevalent upon the earth. Out of the almost infinite time which has passed before the world cooled to its present state, and the ages that still must run ere the world reaches the absolute zero of temperature, is it to be imagined that during an only infinitesimal portion of this time could organised life exist? To assume this is to place oneself in the position of those early astronomers who held that the sun and stars and the infinite universe itself revolved about the earth as centre.

Again, are we to assume that out of an unknown, but probably enormous, number of elements, only some four namely, carbon, hydrogen, nitrogen, and oxygen, are capable of producing vital matter? When we study the properties of these four elements and compare them with those of other known elements we find that there is absolutely nothing which inherently distinguishes them from the other elements. Every property possessed by them is shared to a greater or less extent by the other elements also. Why, then, should we imagine that only these four elements can give rise to living matter? Why they enter so largely into the constitution of living matter upon this earth is probably a pure accident of temperature and pressure. They merely happen to possess the proper degree of volatility and the capacity for exerting chemical forces of the requisite intensity, which make them somewhat more adapted than the other elements to enter into the constitution of living matter under those particular temperature and pressure conditions which hold upon the earth. But we know that the chemical properties exhibited by an element alter very considerably with the temperature and pressure conditions under which it is viewed. Indeed, it has been suggested* that by altering the external conditions upon which we view an element, we can make it assume in succession the various chemical conditions which the various other elements find themselves in at ordinary temperatures and pressures. If this be so, it is difficult to avoid the inference that under other external conditions, other elements would so change their nature as to become capable of entering into the structure of living matter, although under ordinary temperatures and pressures they are quite incapable of so doing.

Sweeping through space are myriads of vast planets, countless swarms of mighty white hot globes and dark suns, whose physical conditions differ utterly from those which hold sway upon the earth. Surely these are not devoid of life? Nay, on such mighty globes life exists on a far grander scale of creation than anything that we can conceive of; life utterly different in form and motion to that which exists on our puny earth, and even composed, perhaps, out of entirely different elements to those which compose the living matter of world life.

Life is old, old as the universe itself. It has always existed generally throughout the universe in some form or other, and always will exist, no matter what happens to our little earth. The protoplasm of the earth is but the product of evolution of untold æons of ages, coming down to us in an unbroken line from ages when the world was a vast liquid globe of white hot material.

* Gautier, *Chem. News*, March 23rd, 1900.

*Chemical News, Oct. 14th, 1904. See also the author's work "*Researches on the Affinities of the Elements*," p.p. 206-225.

All the elements have circulated in succession through its structure, and then passed out again. First at the highest temperatures came the heaviest and least volatile elements, then as the temperature fell they gradually were eliminated and their places were filled by analogous lighter and more volatile elements, until at last living matter assumed its present composition. But this replacement of denser by lighter elements is now almost complete, for the principal elements already present in living matter are carbon, nitrogen, oxygen, and hydrogen. And these it will be noticed are among the very lightest non-metallic elements which, so far as we know, exist. No lighter elements, then, can replace those already present in the organism, and, therefore, there can be no further *very great* alterations in the temperature of living matter in the coming ages; but the world is still cooling. Consequently, age by age, century by century, the contrast between the temperature of living matter and the temperature of the surrounding medium is becoming more and more accentuated, and the difficulty of maintaining life is steadily increasing. I think, therefore, that so far as the surface of this earth is concerned, organic life is entering into its last stage of evolution.

UNIVERSITY OF KIEL, *May*, 1905.

A Raised Beach in Anglesey.

By G. H. BRYAN, F.R.S.

IN the island of Anglesey, about three miles north-east of Beaumaris and about one mile from Penmon, I came across an interesting example of a raised beach, of

Fig. 1.—Section of Boulder Clay near Penmon, Anglesey, with raised beach of sand overlying it.

which the accompanying photographs may give some idea. It is situated in a small bay, and rests on the top of a deposit of boulder clay at a height of some six feet above the existing beach. At the eastern extremity a stratum of broken shells occurs in the sand in several places, and is well shown in the second of the two photographs. In this shell deposit foraminifera are frequent; these are of large size and are mostly similar to the recent forms occurring on the sands below. They are all common species, apparently. Many of the specimens are, however, more or less worn and discoloured by iron oxide. The boulder clay itself is of a dark purple colour.

The existence of these raised beaches is interesting as showing the changes which have taken place in the level of the earth. The section shown in the first photo-

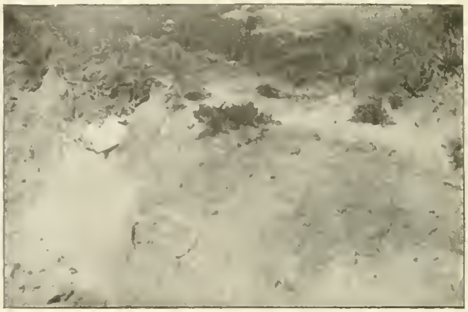


Fig. 2.—Section of the Raised Beach showing the white streaks of Shell Deposit.

graph has been exposed by the action of the sea, which at high tide reaches the foot of the boulder clay which it has exposed, and the identity of the foraminifera in the shell deposit with the recent ones in the sand below suggests that the changes of level have occurred in comparatively recent times.

CORRESPONDENCE.

The Action of Wood on Photographic Plates.

TO THE EDITORS OF "KNOWLEDGE."

DEAR SIRS,—I have read with much interest the article on the action of woods on photographic plates in the dark, which appears in this month's "KNOWLEDGE," and, believing the action due to the actual radio-activity of the wood, I was of opinion that an emanation should be visible under proper conditions, as is the case with the recognised radio-active substances—the intensity of the action of any radio-active substance appearing to depend on the *frequency* of the atomic disintegration rather than on the intensity of disintegration of each individual atom. By using a very sensitive screen, I have distinctly observed a bombardment from a piece of wood (I used white fretwood), each individual scintillation being about as bright as any I have observed from Uranium, Pitchblende, Polonium, or even Radium, the great difference being that, whereas from such substances the emanations pour forth in such numbers as to light up the screen with countless flashes, in the case of the wood they came singly or now and again in twos and threes, with a considerable interval between each. This would seem to account for the comparatively feeble and slow action of woods, as it would of necessity take considerable time before the cumulative effect would become evident.

I shall be very glad to know if scintillations from wood have been observed before.

Yours very truly,
CHARLES W. RAFFETY.

Strathmore, Streatham Common, S.W.
June 8th, 1905.

Electrotyping.

By Dr. F. Mollwo Perkin.

In the article on electrotyping in the January number of "Knowledge" various methods for reproducing medallions, coins, &c., were given. But this does not by any means exhaust the possibilities of electrolytic reproduction. Statuettes, and even large statues, can be, and often are, copied in a similar manner. Thus a statue of the Earl of Eglinton, which is $13\frac{1}{2}$ feet high, was reproduced by Messrs. Elkington and Co., the weight of the electrolytic copper being about two tons. The reproduction of a statue, as may readily be imagined, is not by any means an easy or simple proceeding.

Generally speaking, the original is first formed in plaster of Paris. The plaster cast is then thoroughly saturated with boiled linseed oil or with melted paraffin wax. After standing for some time to allow the oil or wax to thoroughly set and harden, the entire surface is brushed over with graphite, and is then polished, so as to form a homogeneous conducting surface.

The model so prepared has conducting wires fixed against different portions of the surface, so that the electric current may be evenly distributed, and is then connected with the negative pole of the source of current and placed in a copper sulphate bath. When a coating of sufficient thickness has been obtained—about $\frac{1}{16}$ or more of an inch—the figure is removed from the bath and carefully washed. It is now necessary to remove the plaster form, and this is done by cutting the deposited copper in appropriate parts, so that the copper shell can be removed in portions. The fewer cuts that require to be made, the better, so that the portions of shell may be as large as possible.

The parts or "formes" of the copper shell so obtained represent the negatives or moulds upon which the positive is to be deposited. The inner portion of the formes are exposed to the fumes of sulphuretted hydrogen or are washed with a dilute solution of potassium sulphide. By this means the copper becomes coated with a thin film of copper sulphide, which is conducting, but upon which the copper to be deposited will not adhere. The outer surfaces of the mould are varnished to render them non-conducting. The various portions of the shell are then placed in a coppering bath and the current passed. When the deposited copper reaches a thickness of about $\frac{1}{7}$ of an inch, they are removed from the bath and well washed. The freshly-deposited shell is now carefully stripped off from the outer shell and the different parts joined together.

Stereotyping.—The most important application of electrotyping is in the preparation of stereotypes. When a large number of copies of a book require to be run off, and in order not to keep too large a quantity of type set up, a copy is reproduced in stereotype. The following description of the procedure adopted is the principle of the process, although individual firms adopt methods which vary in detail. Suppose it is required to produce a stereotype of a page of a book. The set-up type is placed face downwards upon a wax plate (gutta compositions are very often employed) cast upon a sheet of lead. It is then placed under an hydraulic press, by which means a perfect impression of the type is obtained in the wax. The type is then removed from the wax impression, which is then graphited, being generally first slightly warmed to render it just soft, so that it takes the graphite more thoroughly. Of course, it must not be sufficiently heated to blur the sharp edge of the impression. Pieces of stout brass wire are now pushed through the wax until they come in contact with the graphite at various parts where they will not injure the impression of the type. These pieces of wire are to make electrical contact so that when the current is passed it may be evenly distributed.

The prepared impression is now placed in the coppering bath and subjected to a fairly low current until the whole of it has obtained a complete coating of copper. It is now either left in this bath until a sufficiently thick shell has been produced or else it is taken out and placed in the quick-depositing bath, where a much higher current density is employed and the electrolyte is kept well agitated by blowing air through it. In the quick bath the shell may be finished in an hour or two, but may take a day or two in the slower bath (sometimes it is placed directly in the quick bath without being first treated in the slower one). As soon as a sufficiently thick deposit of copper has been obtained, it is removed from the bath, and if the stereo is small the wax is stripped away by hand. But in cases where the shell is of any considerable size, and, therefore, liable to be damaged, the wax is usually melted out with hot water or by blowing on steam. The galvano is now thoroughly cleansed from adhering wax and graphite by brushing it in hot water and with caustic soda or dilute hydrochloric acid. The next process is to back up the copper, because as the shell is less than one millimetre thick it is much too thin and fragile to use for printing purposes. But before the backing up metal, which usually consists of lead containing about 6 per cent. of antimony to harden it, is poured in, the shell must be tinned, otherwise the lead will not adhere. A very satisfactory way to do this is to first brush the inside of the shell with some soldering fluid, then place the shell face downwards upon a flat iron plate and float the iron plate upon a bath of molten metal slightly hotter than the melting point of tin. As soon as the copper shell has become properly heated, powdered tin is sifted over it, care being taken to give it a perfectly homogeneous coat. The tin melts and alloys with the copper, and now the lead can be poured in and it in turn alloys with the tin. After cooling and machining the edges and planing off the excess of lead, the stereo is ready for use.

Facing stereotypes.—When the copper stereo has been used for some time, owing to the copper being a soft metal, there is a tendency for the sharpness of the impression to become blurred; furthermore, certain printing inks, such, *e.g.*, as red ink, which contains vermillion—sulphide of mercury—act upon the copper and unite with it. In order to get over these difficulties the stereotypes are very often "steel" or nickel faced. The term steel facing is not quite correct, but it has been the custom to call iron when electrolytically deposited steel, because, although its hardness is not due to its carbon contents, yet it has very much the properties of steel. It is more usual to employ iron as a facing rather than nickel, because when used for a considerable time even iron and nickel facings wear off. It is then necessary to reface, but before this can be done it is essential that all of the original facing should be removed. The iron facing is very readily removed with dilute sulphuric acid, which has practically no action on the copper, but nickel is extremely difficult to

dissolve, and the copper is very likely to be damaged at the same time. In order to steel face an electrotype, the surface is thoroughly cleansed from all traces of grease and made the cathode in an iron bath; a typical solution is one consisting of 100 grm. of ammonium chloride and 125 grm. iron sulphate, or 150 grm. iron ammonium sulphate in one litre of water. Generally a high current density is employed for one or two minutes, after which a current of 0.4 ampere to the square decimetre is employed for about five or 10 minutes, when the stereo is removed and carefully washed and dried. Nickel facing is done in the same manner, a nickel bath being employed in place of the iron bath, and the stereo left in for from seven to 10 minutes.

Reproduction of Gramophone Records.—As an illustration of the extreme accuracy of the impressions obtained by electrolytic means, the reproduction of gramophone records might be mentioned. As is well-known, the original gramophone record is made on a wax or composition cylinder, the mechanism of the instrument causing impressions of various degrees of fineness to be made upon the cylinder, the thickness depending upon the tone and pitch of the sound to be reproduced. Now, of course, the least fault or unevenness in the reproduction would completely ruin the record. In reproducing a record in copper the wax cylinder is carefully graphited and then, after being connected by means of conducting wires with the negative pole of the source of current, placed in a rapid depositing bath, where it is left for from 70 to 80 hours, a current of from three to four amperes per square decimetre being employed. By this means a good thick negative is obtained which can be used for producing duplicate copies of the original voice.

Dentistry.—Electrotyping is also employed in dentistry for producing mouth plates, &c. A model of the part of the mouth for which a plate is required is taken in wax and a plaster cast obtained from the wax model. The plaster cast is then prepared as already described, and placed in a silver bath, a silver electrotype being prepared; when the silver deposit is sufficiently heavy the model is placed in a gold bath and a heavy coating of gold deposited upon it. Drs. Pfanhauser and Hillischer have also experimented successfully with pure nickel in place of silver or gold.

Deposition upon Flowers, &c.—I will conclude this article by describing an interesting and artistic method for coating plants, leaves, or even insects with metallic deposits. A flower or leaf will not, under ordinary circumstances, conduct the electric current, therefore it is not possible to coat it with metal. It is, however, possible to render the surface conducting by chemical means in such a manner that the structure of the leaf is not spoilt. If a leaf is dipped into an ammoniacal solution of a silver salt and then exposed to the fumes of phosphorus, the phosphorus reduces the silver salt, and the whole surface becomes coated with a very thin film of metallic silver. The surface of the leaf is now conducting, and if a wire is fastened to the stalk and the leaf placed in a copper-plating bath, a coating of copper of any desired thickness can be deposited upon the leaf. A better method is to dip the leaf or flower into an alcoholic solution of silver nitrate and to then, after draining off the excess of the solution, expose to the action of sulphuretted hydrogen gas. By this means a thin and homogeneous film of silver sulphide—which will conduct the electric current—is obtained. The leaf is now placed in the depositing bath and coated with copper or silver as the case may be. If the operation is carefully carried out with a very low current and only a thin coating of metal deposited, all the veins and markings of the leaf remain. Leaves, flowers, and even insects, such as beetles or flies, when coated in this way can be kept for years without withering or decomposing. Of course, the actual leaf or insect is not seen, but is covered with a metallic shell which almost exactly represents the original.

Star Map.—No. 3.

Cetus, Eridanus.

The constellations here shown are of no special interest. It may be noticed that there are two boundary lines dividing Fornax from Eridanus. The enclosed portion is included in the latter constellation by Proctor and some others, but, according to most authorities (including Gould) belongs to Fornax, and is lettered accordingly. The star at the top of the map marked μ is included by Proctor (and B.A.C.) in Aries, but other authorities call it μ Ceti.

α *Piscium* (I. h. 56 m. + 2° 14′), a double star of magnitudes 3 and 4. Distant 3½″.

o *Ceti (Mira)* (II. h. 14 m. − 3° 25′) a remarkable variable, usually varying from about 3rd magnitude to 9th. Though it has long been known, having been one of the first variables noted, it is still an enigma. Its period seems to vary greatly, but is usually about 331 days. In 1779 it was estimated as 1st magnitude; in 1868 it never attained more than 5th magnitude. During the last twelve periods the magnitude at maximum has varied from 2·5 to 4·7. The spectrum shows no signs of the star being double, and the variability is probably due to its own disturbances rather than to any outside cause.

γ *Ceti* (II. h. 38 m. + 2° 46′), a double star, distant 3½″. One of 3rd magnitude, yellow; other of 6th magnitude, blue.

θ *Eridani* (II. h. 54 m. − 40° 45′), a double star, distant 8·2″. Magnitudes 3½ and 5½. This star is supposed to have dwindled considerably in magnitude, having been classed as 1st magnitude in the time of Ptolemy, though now considered as 3·06.

With our special number for the British Association meeting will be issued Map No. 12 (South Polar Regions), which should prove of use to those visiting South Africa. With the August number, Map No. 6 (Leo and Cancer) will appear, which will show the region around the sun at the time of the coming eclipse.

The Word "Patent."

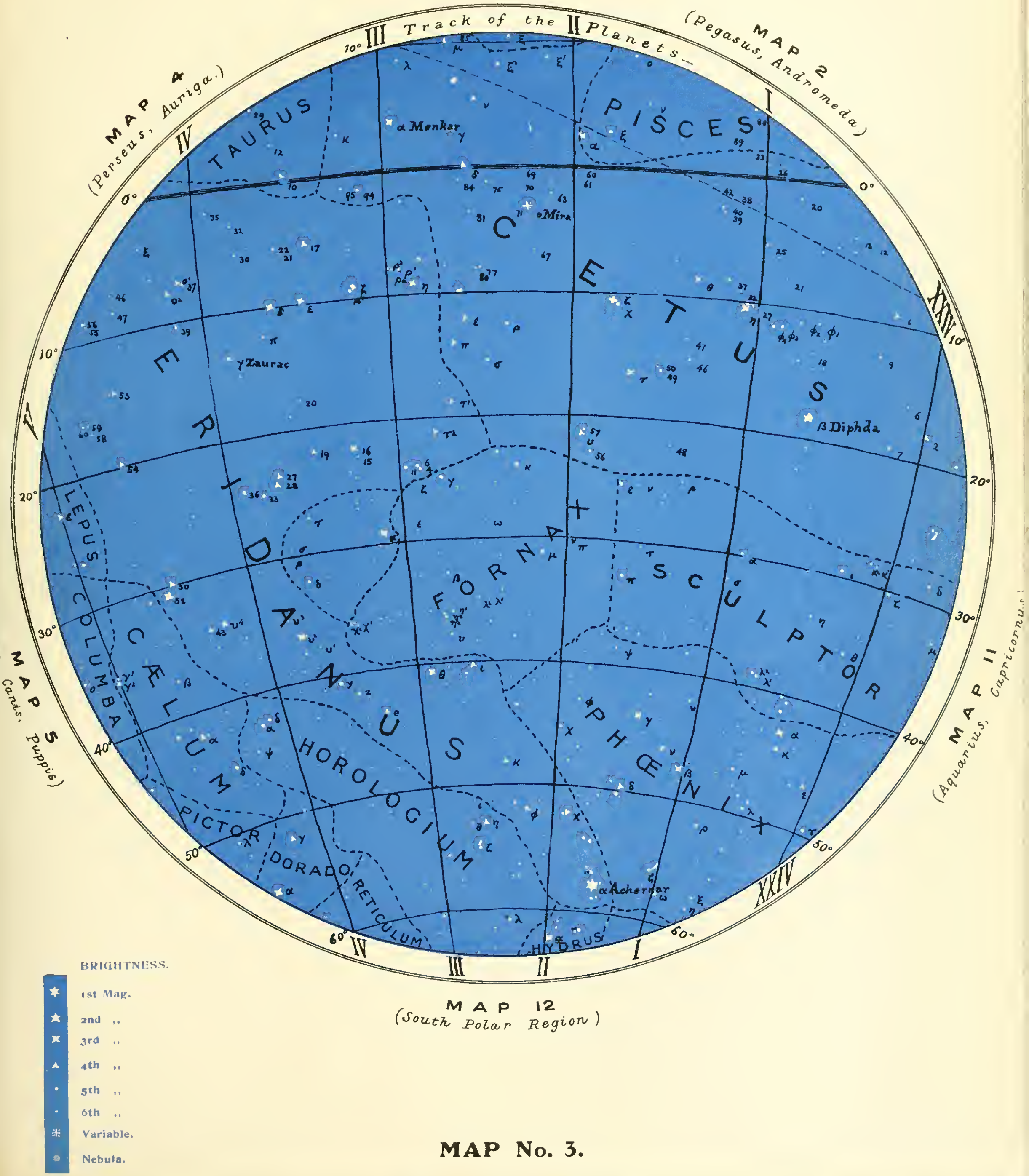
To the Editors of "Knowledge."

Sirs,—The word "Patent" is one of those curiosities of the English language which tend to make it so puzzling to foreigners, and even to ourselves. Now this word is perhaps most generally pronounced *Paytent*, but in the profession it is more usually referred to as *Pattent*. There is one reason which I should like to point out in favour of using the former, and that is the confusion that is sometimes caused in mistaking the latter pronunciation for the word "Pattern." Jones may say, "That machine is my pattern," and Brown may later say, "That machine is Jones's patent, I heard him say so himself." When shall we take to teaching phonetics?

Yours faithfully,

R.

MAP No. 3.



MAP No. 3.

Cetus, Eridanus.

The Migration of Flat-Fish.

By J. Travis Jenkins, D.Sc., Ph.D.

At the present time when so much is heard of over-fishing and the consequent depletion of the fishing grounds, the question of the movements of sea-fish is one of considerable practical importance.

The majority of scientific experts agree that round fish, *i.e.*, fish of the herring and cod type, perform migratory movements of considerable magnitude, but as regards flat fish, *i.e.*, plaice, soles, and flounders, the consensus of opinion is by no means so unanimous.

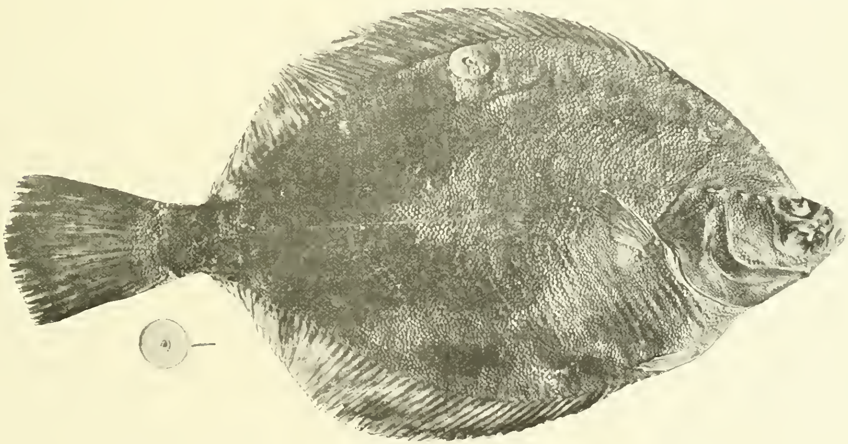
The International Committee for Investigation of the Seas, which has quite recently been established, has taken up, among other problems, the question of the migration of members of the flat fish family or Pleuronectidæ.

This international committee consists of scientific experts nominated by the Governments of England, Norway, Sweden, Germany, and Holland, and is subsidised by grants from the respective Governments.

Batches of marked Pleuronectids, chiefly plaice, have been marked from time to time and then liberated at various points in the North Sea. The mark used consists of a silver wire, which is threaded through the body of the fish in the position indicated in the diagram. To this wire are attached on the under side a bone button (shown to the left beneath the tail of the fish), and on the upper side a numbered brass label, in the present instance L. 169. Each fish is carefully measured and labelled, the whole operation from the time the fish is removed from the tank to the time it is replaced taking less than one minute.

It is hoped that by these experiments the amount and nature of the migration of flat fish will be determined; and attempts will be made to show the influence of the environment on migration. The intensity of fishing in any given area can be determined by the proportion of fish recaptured to the total number of marked fish returned to the sea. Since each marked fish is carefully measured both when it is returned to the sea and when re-captured, the rate of growth can also be determined. Plaice seem to withstand the marking operation wonderfully well, but soles are far more difficult to deal with successfully. No doubt other results will be arrived at, notably the efficacy of closed grounds in maintaining a reserve of fish and the effect of the density of fish population on the rate of growth.

The interest and co-operation of the fishermen is secured by means of a system of rewards payable for marked fish, the amount depending on the amount of information as to the locality of re-capture. It is surprising to find how many hands a marked fish will occasionally pass through before the label is detected. In one instance a label which was returned showed unmistakable signs of having been in the frying-pan.



Marked Plaice which travelled 40 miles in 20 days and was then recaptured.

It is yet somewhat premature to discuss the results in detail, but it may be said that the idea of plaice and soles being sedentary fish is now exploded. Plaice have been returned which have travelled 110, 130, and 210 miles respectively. As to rate of growth, an eight-inch plaice grows on the average from two-and-a-half to three inches per annum. More detailed reports will shortly be issued and are awaited by practical fishermen and biologists with equal interest.

Scientific Agriculture.

We have received from the Committee of the Lawes Agricultural Trust a copy of the Directors' report on the work done at the Rothamsted Experimental Station for the year ending March 31st, 1905. The well-known experimental fields are still continued without any essential change; in addition a new field has been laid out to test the residual value of various manures in the

second and succeeding years after their application. Other experiments deal with calcium cyanamide, the new manure containing nitrogen derived from the atmosphere, and with the various cultivations of bacteria which have been recently introduced for the inoculation of leguminous crops, with the view of making them more efficient collectors of atmospheric nitrogen.

During the year in question seven papers have been issued from the Station in the "Transactions of the Chemical Society," the "Journal of Agricultural Science," &c., all of which deal with investigations on the soil, methods of soil analysis, &c. The annual losses of carbonate of lime in the Rothamsted soil has been determined, both that due to natural agencies and that caused by the use of manures. Certain restorative actions have been investigated which account for the maintenance of the fertility of many soils which are almost devoid of lime. Another of the papers deals with the remarkable accumulations of fertility in certain plots of land which have been allowed to run wild for the last twenty years, and have in that time gained nitrogen to an extent not readily explicable by the accepted theories.

A considerable list of investigations in progress is indicated, in which respect the Station receives considerable help from several voluntary workers, *e.g.*, two Carnegie Research scholars from the University of Edinburgh, and other post graduate students from Oxford and Cambridge are accommodated and provided with material for investigation, so that the Station, with its unrivalled opportunities for research, is becoming a training ground for experts in agricultural science.

The Lawes Trust Committee continue to find their income very inadequate to the proper development of the Station, only donations and subscriptions from various sources, including £300 from the Goldsmiths' Company, £50 from the Clothworkers' Company, £50 from Lord Rothschild, &c., have prevented a serious deficit on the year's working. Mr. J. F. Mason has also promised to erect and equip a new laboratory for agricultural bacteriology, which will be the first of its kind in this country, as a continuance of the experiments carried on for many years by his father, the late Mr. James Mason, at Eynsham Hall, Oxon.

Radiation Pressure.

Prof. J. H. Poynting, F.R.S., the newly-elected President of the Physical Society, delivered an interesting address before that Society on "Radiation Pressure," of which the following is an abstract:—

"A hundred years ago, when the corpuscular theory held almost universal sway, it would have been easier to explain the pressure of light than it is to-day, when it is certain that light is a form of wave-motion. The means at the disposal of early experimenters were inadequate to detect so small a quantity; but if the eighteenth century philosophers had been able to carry out the experiments of Lebedew and of Nichols and Hull, and had they further known of the emission of corpuscles revealed to us by the kathode stream and by radio-active bodies, there can be little doubt that Young and Fresnel would have had much greater difficulty in dethroning the corpuscular theory and setting up the wave theory in its place. The existence of pressure due to waves, though held by Euler, seems to have dropped out of sight until Maxwell, in 1872, predicted its existence as a consequence of his electro-magnetic theory of light. The first suggestion that it is a general property of waves is probably due to Mr. S. T. Preston, who, in 1876, pointed out the analogy of the energy-carrying power of a beam of light with the mechanical carriage by belting, and calculated the pressure exerted on the surface of the sun by the issuing radiation. It seems possible that in all cases of energy transfer, momentum, in the direction of transfer, is also passed on, and that there is, therefore, a back pressure on the source. Though there is as yet no general and direct dynamical theorem accounting for radiation pressure, Prof. Larmor has given a simple indirect mode of proving the existence of the pressure which applies to all waves in which the average energy density for a given amplitude is inversely as the square of the wave-length. He has shown that when a train of waves is incident normally on a perfectly reflecting surface, the pressure on the surface is equal to $E\,(1+2u/U)$, where $E/2$ is the energy density just outside the reflector in the incident train, U is the wave-velocity, and u the velocity of the reflector, supposed small in comparison with U. In a similar manner it can be shown that there is a pressure on the source, increased when the source is moving forward, decreased when it is receding. It is essential, however, that we should be able to move the reflecting surface without disturbing the medium except by reflecting the waves. Though Larmor's proof is quite convincing, it is interesting to realise the way in which the pressure is produced in the different types of wave-motion. In the case of electro-magnetic waves, Maxwell's original mode of treatment is the simplest. A train of waves is regarded as a system of electric and magnetic tubes transverse to the direction of propagation, each kind pressing out sideways; that is, in the direction of propagation. They press against the source from which they issue, against each other as they travel, and against any surface on which they fall. In sound-waves there is a node at the reflecting surface. If the variation of pressure from the undisturbed value were exactly proportional to the displacement of a parallel layer near the surface, and if the displacement were exactly harmonic, then the average pressure would be equal to the normal undisturbed value. But consider a layer of air quite close to the surface. If it moves up a distance, y, towards the surface, the pressure is increased. If it moves an equal distance, y, away from the surface, the pressure is decreased, but to a slightly smaller extent. The excess of pressure during the compression half is greater than its defect during the extension half, and the net result is an average excess of pressure on the reflecting surface. Lord Rayleigh, using Boyle's Law, has shown that this average excess should be equal to the average density of the energy just outside the reflecting surface. In the case of transverse waves in an elastic solid, it can be shown that there is a small pressure perpendicular to the planes of shear, that is, in the direction of propagation, and that this small pressure is just equal to the energy density of the waves. The experimental verification of the pressure of elastic solid waves has not yet been accomplished, but the pressure due to sound-waves has been demonstrated by Altberg, working in Lebedew's laboratory at Moscow, the pressure obtained sometimes rising to as much as 0.24 dynes per sq. cm. By means of a telephone manometer it was found that through a large range the pressure exerted on a surface was proportional to the intensity of the sound.

"Both theory and experiment justify the conclusion

that when a source is pouring out waves, it is pouring out with them forward momentum which is manifested in the back pressure against the source and in the forward pressure when the waves reach an opposing surface, and which, in the meanwhile, must be regarded as travelling with the train. It was shown that this idea of momentum in a wave-train enables us to see the nature of the action of a beam of light on a surface where it is reflected, absorbed, or refracted without any further appeal to the theory of the wave-motion of which we suppose the light to consist. In the case of total reflection there is a normal force upon the surface, in the case of total absorption there is a force normal to the surface and a tangential force parallel to the surface; while in the case of total refraction there is a normal force which may be regarded as a pull upon the surface or a pressure from within. In any real refraction there will be reflection as well, but with unpolarized light, in the case of glass, a calculation shows that the refraction-pull is always greater than the reflection-push, even at grazing incidence. An experiment, made by the President in conjunction with Dr. Barlow, was described to serve as an illustration of the idea of a beam of light being regarded as a stream of momentum. A rectangular block of glass was suspended by a quartz fibre so that the long axis of the block was horizontal. It was hung in an exhausted case with glass windows, and a horizontal beam of light was directed on to one end of the block so that it entered centrally and emerged centrally from the other end after two internal reflections. Thus a stream of momentum was shifted parallel to itself, or in this particular case a counter-clockwise couple acted on the beam. By suitable means the clockwise couple on the block, due to the pressures at the two internal reflections, was distinctly observed and approximately measured. The result obtained was of the same order as that deduced from the measurement of the energy of the beam by means of a blackened silver disc.

"The extreme minuteness of these light forces appears to put them beyond consideration in terrestrial affairs, but in the solar system, where they have freer play, and vast times to work in, their effects may mount up into importance. On the larger bodies the force of the light of the sun is small compared with the gravitational attraction, but as the ratio of the radiation pressure to the gravitation pull varies inversely as the radius if the density is constant, the pressure will balance the pull on a spherical absorbing particle of the density of the earth if its diameter is about a hundred thousandth of an inch. The possible effects of radiation-pressure may be illustrated without going to such fineness as this. In the case of a particle of the density of the earth, and a thousandth of an inch in diameter, going round the sun at the earth's distance, there are two effects due to the sun's radiation. In the first place, the radiation-push is $\frac{1}{100}$ of the gravitation-pull, and the result is equivalent to a diminution in the sun's mass. In the second place, the radiation absorbed by the particle, and given out again on all sides, is crushed up in front as the particle moves forward and is opened out behind. There is thus a slightly greater pressure on the advancing hemisphere than on the receding one, and this appears as a small resisting force in the direction of motion. Through this the particle tends to move in a decreasing orbit, spiralling in towards the sun. As there is good reason to believe that some comets, at least, are composed of clouds of dust, there is hope that some of their eccentricities may be explained by the existence of radiation pressure. If the particles of a dust cloud circling round the sun are of different sizes or densities, the radiation accelerations on them will differ. The larger particles will be less affected than the smaller, will travel faster round a given orbit, and will draw more slowly in towards the sun. Thus a comet of particles of mixed sizes will gradually be degraded into a diffused trail lengthening and broadening, the finer dust on the inner and the coarser on the outer edge. If a planet, while still radiating much energy on its own account captures and attaches to itself, as a satellite, a cometary cloud of dust in which there are several different grades, with gaps in the scale of size, it may be possible that in course of time the radiation pressure effects will form the different grades into different rings surrounding the planet. Such may possibly be the origin of the rings of Saturn."

REVIEWS OF BOOKS.

Geology: Processes and Their Results. By T. C. Chamberlin and R. D. Salisbury (Murray). Pp. XIX. and 654, plates 24; 21s. net.—This excellently printed and fully illustrated work will meet with a hearty welcome from English geologists. Its treatment of the subject is original, and proceeds from the point of view that the science is a unit, that its one theme is the history of the earth, and that the discussions of dynamic geology, physiographic geology, &c., apart from their historical bearings, lose much of their significance and interest. The present condition of scientific knowledge is set forth in such a way that the student will be introduced to the methods and spirit of the science, and a sympathetic interest excited in its historical progress.

In a chapter devoted to the work of running water, examples are freely drawn from North American rivers, in which are seen every condition of existence, old, middle-aged, and juvenile. In our country, we have few instances which show, for instance, such as does the Mississippi, the ox-bow lakes, evidence of the former existence of meanders which have since been abandoned. Most of our rivers are in a condition of early old-age, and only by some sudden tilt of either east or west coast, or an uprising of the central axes of our country, would rejuvenation of our rivers take place, and the cycle commence over again.

It is pleasing to see the authors utilising the miniature deltas, which occur anywhere on a muddy coast, or even in a street in rainy weather, where a drain has been choked up, to illustrate the formation of the great deltas of the world. I remember being greatly struck by the deltas which are formed at the base of the muddy parts of the Lower Greensand Cliffs, near Luccombe Chine, in the Isle of Wight. Homely object lessons can be obtained of immense value from such examples close at hand.

In the chapter on Structural Features of Igneous Rocks, the authors discuss the origin of hexagonal columnar structure. In nature, generally speaking, the hexagon is the result of the pressure exerted by the walls of circles upon one another. In the cooling of homogeneous lava, it is postulated that it contracts about equally in all directions. If the contractile force be regarded as centring about a number of equidistant points, then at any one point the least number of cracks which will relieve the tension in all directions is three, and these cracks, if radiating symmetrically, would enclose angles of 120°, the angle of the hexagonal prism. The theory is interesting, but scarcely explains the breaking-up of the columns into parallel laminæ, nor why the supposititious points about which the contractile force centres should be, almost invariably, immediately beneath one another. If they were not, the columnar structure would be lost.

We are so accustomed to talk about the extinct volcanoes in the moon that we perhaps sometimes overlook the theory that holds weight in some quarters, that what appear to be craters may be indentations produced by infalling meteorites or planetoids. The reproduction of a portion of a photo-

graph of the moon's surface in the volume before us certainly suggests, as a cause of the shallow craters, the falling-in of bodies, as much as the belching-out of lava or bombs. The reproduction in another part of the book of fossil rain-markings bears a remarkable resemblance, on a small scale, to what have been long regarded as lunar craters, except that the small central cones are nearly always absent in the former. This may, however, be due merely to the great fluidity of water, and because the rain-drops were quickly absorbed in the sedimentary deposit forming, and since the falling body was more fluid than the receiving body. Let the falling body be the more solid of the two, then the more fluid will give rise to a central cone, on the disappearance within of the falling body, and the permanence or otherwise of the cone will depend on the degree to which the receiving body has approached solidity. The subject is fascinating. The moon may have been the recipient of a bombardment, rather than the bombarding element itself.

In the 76 pages devoted to the work of snow and ice we have this most difficult subject dealt with in an admirable manner. The illustrations are superb, and show, in many cases very clearly, the remarkable stratified formation of exposed sections of glaciers. Æolian denudation receives due recognition in the chapter dealing with the atmosphere as a geological agent, and the migration of dunes are admirably illustrated. There is nothing but praise to be said for the work, and we hope that it may make its way into every important library, and into the hands of many who may feel repelled by the strange. E. A. M.

Electro Chemistry.—Practical Methods of Electro-Chemistry, by F. Mollwo Perkin (Longmans, Green and Co.); price 6s. net. —Sir William Ramsay has recently spoken of the enormous revolution in our chemical industries, only as yet dimly perceived, which awaits the application of electro-chemistry to their development; and since what is to-day done in the laboratory will to-morrow have to be done in the manufactory, the greatest importance attaches to the establishment of a sound method in the teaching of electro-chemistry to students. That end is brought perceptibly nearer by Dr. F. Mollwo Perkin's sound laboratory guide to these electro-chemical methods, which in recent years have undergone such rapid development and have attained such extreme importance. The volume is above all things practical; it is what it professes to be, a real guide and instructor to the student. The ground having been cleared by definitions of electrical magnitudes and units, and by descriptions of measuring instruments and electrolytic apparatus, the instruction proceeds by graduated steps to the actual methods of electro-chemical analysis. The conditions of the quantitative electro deposition of the metals; a section on quantitative oxidation and reduction of the electrodes; the separation of metals from mixed solutions of their salts; and finally preparative electro-chemistry—both of inorganic and of organic compounds—are the chief divisions of the book and of its instructional chapters. It is supplemented by a table of five-figure logarithms, with instructions for their use; and it bears from title to imprint the evidence of the carefully considered work of a scientist who is as well able to impart knowledge as to accumulate and digest it.

The Rational Almanac (M. B. Cotsworth, Holgate, York; price 5s. net). This is an odd shaped book of over 470 pages, crammed full of writing, diagrams, and illustrations, and it takes some little time to find out exactly what it is all about. One naturally turns to the "Summation" at the end, where one might expect to find some simple and succinct explanation, but this alone extends over 100 pages, and seems to be a history of the world from early times. A large part of the book is devoted to explanations of the probable astronomical purposes of the Pyramids and many druidical and other erections, and their practical use in connection with the calendar. But we need not refer further to them, interesting though they be. The real object of the book is to suggest a reform in our calendar, and one in favour of which much can be urged. It is to divide the year into 13 months of 28 days each. This would be very convenient, as the days of the week would run concurrently with the days of the month. It is suggested, to complete the year, that Christmas Day should be extra, and not count either as a week-day or day of the month. The author lays stress on what we should consider another matter, that is "the inconvenience which results from drifting Easters," &c. These moveable feasts can be, and we think ought to be, done away with (for business purposes) without otherwise altering our present well-established calendar.

Studies in General Physiology, by Jacques Loeb. (Chicago. London: Fisher Unwin; price £1 11s. 6d. net; 782 pp.)—These two volumes will be welcomed by all students of Comparative Physiology, who have hitherto been obliged to seek for Professor Loeb's papers in the various American and German periodicals in which they have appeared. "Control of the Phenomena of Life" is the dominant note of his work, which deals with the mechanical determination of (*a*) animal motion (heliotropism, geotropism, &c.); (*b*) animal organs (regeneration, heteromorphosis, &c.); (*c*) life itself (fertilisation, artificial production of normal embryos from unfertilised ova, &c.) The arrangement of the book is a little tiresome, the papers being reproduced in order of publication, not grouped together by subject. On the other hand, the vital interest of Loeb's work consists in the development of one point out of another, and we can follow his train of thought from first to last in these studies. The general reader would do well to turn in the first instance to p. 497 of Part II., where he will find an admirable 10-minutes' lecture on "The Physiological Problems of To-day" (delivered 1897). In this the importance of comparative physiology, which "alone enables us to discriminate between the general properties of living matter and the functions of specific organs, such as the blood, the nerves, the sense-organs, chlorophyll, &c.," is insisted on. Professor Loeb pleads for the extension of that field of comparative physiology which he terms physical morphology, or "the connection between the chemical changes and the process of organisation in living matter," and to this fascinating subject many of his studies are devoted. Of late he has turned from the structural phenomena common to plants and animals to the constitution of living matter itself, as interpreted by physical chemistry (stereo-chemistry, or the geometrical configuration of the molecule, osmotic pressure, &c.); and the remainder of the book is devoted to the brilliant series of experiments upon the dissociation of electrolytes—physiological action of positive or negative ions, rate of their diffusion through the living tissues, and so on—by which Professor Loeb has, perhaps more than any other physiologist, established the fundamental importance of ionic dissociation in physiology and pharmacology.

Animals I Have Known. In this companion volume to his "Birds I Have Known," (pp. 304, 40 illustrations; T. Fisher Unwin; price 5s.), Mr. A. H. Beavan states that it has been his object simply to record his experiences of animals (*i.e.*, mammals) in various lands, without reference to scientific theories as to their origin and distribution. Had he adhered strictly to this resolution all might have been well, and we should not have been informed that the Australian platypus is the only mammal that lays eggs, and that the South American vampire abrades the skin of its victims with its canine teeth. If an author will enter upon technicalities, he should take means to ascertain that they are correctly stated. A large portion of the book is devoted to the mammals (wild and domesticated) of our own country; but Mr. Beavan has had the good fortune to visit Australia and South America, and has much to tell us (which is for the most part well worth reading) concerning the very remarkable mammalian faunas of those two countries. Of especial interest are his observations with regard to the tail of the Tasmanian wolf, which, he says, is essentially part of the creature's body, and cannot therefore be "wagged." The numerous illustrations are for the most part excellent. If only the author had asked a scientific naturalist to revise the proof sheets, we should have had nothing but praise for his little volume.

The Inventor's Guide to Patent Law and the New Practice.—By James Roberts, M.A., LL.B., Barrister-at-law (John Murray), price 2s. 6d. net, 100 pp. The inventor who is about to take out a patent, whether already experienced in such matters, or a novice, will always be glad to consult a small book which gives clear instructions as to the *modus operandi* of obtaining the patent, and of the legal procedence, especially now that several important changes have been made. This book admirably fulfils the requirement, and, being by a barrister and author of a larger work on the same subject, may be looked

upon as reliable and unbiassed. We are frequently having foisted upon us guide books of "How to take out a Patent," which prove to be nothing more than the advertisement of some enterprising firm of patent agents, and such works, though frequently quite correct, one is bound to regard with a certain amount of suspicion.

Electro-magnetic Theory of Light, by C. E. Curry, Ph.D. Part I.; pp. vi. + 400. (London: Macmillan; 12s. net.)—This is one of those books of which we would speak nothing but good if we could. It has evidently been laboriously compiled, and the whole ground has been covered of that portion of the theory which was developed by Maxwell himself. More modern developments which must include such matters as dispersion, which was left unexplained by Maxwell in his Treatise [but which were *understood* by him as is shown by an examination question set by him—as pointed out by Lord Rayleigh], have been relegated to a second part. Each section is followed by a large number of examples, very many of which have been excellently chosen. Since these are often worked out in detail they form an excellent means for a student to familiarise himself with the subject. When we have said this, however, any praise of a fairly enthusiastic kind is at an end. The style in which the book is written is not good; indeed it is repellent. We have pored over many paragraphs without being able to obtain their meaning. Special points which seem to be peculiar to the author displease us most of all. We do not like his use of the phrases primary and secondary waves in a sense distinct from that in which they are already used—viz., in connection with Hugyen's theorem. Still less do we approve of the whole page devoted to a fanciful analogy to primary and secondary currents by which an attempt is made to justify the new use to which he puts these phrases. Simple methods of proof of theories which are familiar to us are replaced by elaborate and confusedly stated methods without any gain in accuracy. On the whole we have said enough to indicate our opinion; and conclude by stating that the publishers have done their part in a most excellent manner.

The Norwegian North Polar Expedition, 1893-6. Edited by Fridtjof Nansen. Vol. VI. (Longmans, Green and Co.; price 36s. net.) This great volume deals with the meteorological results of the expedition, and is the work of Professor H. Mohn, who planned the meteorological work to be conducted, and superintended the equipment sent with the *Fram*. Such a great work, conducted with skill and care, forms an important addition to scientific literature. The observations, continued through three years of travel in regions hitherto unknown, were mostly conducted by Captain S. Scott Hansen, who had received special instruction in this subject from Professor Mohn. The book is mainly divided into three portions; the first describing the instruments and observations; the second, the actual diary tables of observations; and the third the results worked out. The observations were made every four hours, and show the direction and velocity of the wind, the barometric pressure, the temperature, the vapour-tension, relative humidity, and clouds. As regards the direction of the wind, which, by the way, has an important bearing on the probabilities regarding the fate of the Andrée expedition, a cursory glance would lead one to suppose that the various winds were fairly equally prevalent, some predominating at certain seasons. The value of this collection of observations is the more evident seeing that they extend over three years, for otherwise one might be led into supposing that certain winds predominated during certain months; but the records of other years seem, in most cases, to prohibit any such conclusion. In July, the month during which Andrée started in his balloon, the prevailing winds were—1894, W.N.W. and W.; 1895, W. and W.S.W.; 1896, S.W. and S.S.W. As regards the velocity of the wind, the monthly means vary from about three to five metres per second. The velocity, as may be expected, was on the average greater during cloudy weather than with a clear sky. The maximum velocity recorded was only 18 metres per second, and the occasions were very rare when this figure was approached, so that anything approaching a real storm was rare. The barometric pressures call for no comment, varying as a rule between 740 and 780 mm., but when we come to temperatures we find some unusual figures. The coldest month was apparently March, with a mean of -37° C. the minimum recorded being -52°. In July and August we occasionally find a mean daily temperature just above freezing point. At the end of the book are a number of charts and diagrams.

Ambidexterity, or Two-Handedness and Two-Brainedness. By John Jackson (Kegan Paul). This is a large book to devote to so little-studied a subject, and we hope it may be the means of bringing forward the importance of that most useful accomplishment of being able to use both hands, or perhaps we should say either hand, for all ordinary purposes. To be able to write two letters simultaneously, or to draw two different pictures at the same time, is certainly an extraordinary feat of dexterity, but is now described as being easily learnt. One hand at a time is, however, sufficient for most people to employ, and it is certainly desirable to acquire the knack of using the left hand for writing and other purposes.

A Catalogue of Zodiacs and Planispheres, by the Rev. A. B. Grimaldi, M.A. (Gall and Inglis), is a most useful compilation describing the various records from the earliest times of zodiacs in all countries. The number of entries is 1,444. Some of them are a little vague, as, for instance, No. 148, which reads: "A Chinese zodiac is mentioned by Pettigrew," and but few of them have the date or supposed age of the record. Nevertheless, the list should prove of great value to all interested in this subject.

Petrol Motors Simply Explained. By T. H. Hawley (Percival Marshall; price, 1s. net). This is one of those useful little manuals intended to instil into the mind of the Man in the Street some knowledge of the working of the machine that carries him about. In the preface the author explains that "the object aimed at is rather a simple explanation of the principles governing the action of the petrol motor, and the manner in which the power so generated is utilized to propel the vehicle, together with a few hints on control mechanism and driving."

Notes and Questions in Physics. John S. Shearer, Ph.D. (Pp. vii. + 281. New York: The Macmillan Company; London: Macmillan and Co.; price 7s. 6d. net).—The object of this volume is to provide a collection of examples in physics with a sufficient number worked out to suggest methods in typical cases. The fact that students continually complain of their inability to solve simple problems in physics is a clear indication that the fundamental principles are not fully grasped; and it is essential therefore to supplement lecture and laboratory work by a reasonable amount of problem work. It is in this way only that a student learns whether he has really understood a principle. The greater number of the problems selected here can be worked by simple algebra or arithmetic; though in a few cases the calculus is necessary. It is obviously intended that the book should be used with the assistance of a teacher, since answers are not given; the private student is hereby put at a disadvantage, for he has no test as to the accuracy of his work. There is surely very little objection to including the answers in any book of collegiate standing, whatever method may be found best for a school book. If a student who has come to years of discretion thinks right to merely "crib" the answer he reaps his reward. Such a man will prove of little use in this world, at any rate. The problems are judiciously chosen, so that both the academic and the technical student is catered for. We notice a few mistakes. There are unfortunately some in the tables at the end. When are text-book writers going to realize that the fundamental standards of mass and length are no longer the old ones "kept in the Archives at Paris." Is the work of the International Bureau a small thing that it should be so ignored?

Elementary Microscopy. By F. Shillington Scales, F.R.M.S. (Baillière, Tindall, and Cox; price 3s.) A handbook for beginners, which is thoroughly practical, concise, and explanatory. With so many modern improvements of detail, most of the larger handbooks on the microscope are becoming out of date, and they are, moreover, as a rule, slightly beyond the requirements of the mere beginner, who wants to know in as few words as possible what sort of instrument to purchase and how to use it. "Nature, as revealed by the microscope, is quite outside the scope of this little book," which is very properly confined to descriptions of the instrument and its accessories, with hints on its manipulation, and methods of mounting objects for inspection. There are 78 good, clear

illustrations, and a useful list of the principal books on the subject is added.

Natural History in Zoological Gardens.—By F. E. Beddard, F.R.S., &c. (London: Archibald Constable and Company, Limited; price, 6s. net). From his position as head of the coroner's (otherwise "prosector's") department at the establishment in the Regent's Park, the author of this well-illustrated little volume of something over three hundred pages has enjoyed unrivalled opportunities of acquiring information with regard to the manners and customs of animals in menageries; and when we first opened the covers we were in hopes of finding that such information had been made public, and that we should find out the average lengths of the lives of different species in captivity, and from what causes they generally perish. To our intense disappointment, we soon found that the work, although it undoubtedly gives a few data on these points, is of a totally different class, being, in fact, a kind of sketchy natural history of terrestrial and aërial vertebrates, as exemplified mainly by species to be met with in zoological gardens. From this point of view (and we have really no right to criticise it for what it is not) the book may be pronounced as fairly satisfactory, and as conveying a large amount of information, although, from the nature of the case, comparatively little is novel. Mr. Beddard treats his subject from the systematic point of view, and consequently takes the various "orders" and species in serial sequence, devoting the largest amount of space to mammals, and omitting fishes altogether, as being not generally represented to any important extent in menageries—unless, indeed, as food for seals. For the same reason whales are omitted from the purview; and it is on account of such omissions that we think the work would have been much better if the animals had not been described systematically. As a minor matter, we confess to being utterly puzzled by the titles selected for some of the chapters. For instance, we find the fourth headed the "Deerlet," and yet it contains notices of such animals as elephants, lions, tigers, &c.; while under the title of the "Polar Bear" we find included such animals as seals and rodents. Surely no chapter-headings at all would have been far preferable. Again, we must venture to take exception to some of the absurd "English" names manufactured for some of the animals described, such as (p. 285) the "adorned ceratophrys," which is a survival of the old bad principle of attempting a half-translation of the scientific names once adopted generally in the gardens. As regards illustrations, the book is for the most part all that can be desired; and, although it cannot be described as of enthralling interest, while, in our opinion, it would be all the better for the omission of many passages which we suppose are meant to be humorous, it undoubtedly contains a very large amount of zoological information.

A Student's Text-Book of Zoology, by Adam Sedgwick, F.R.S., &c. Vol. II. (London: Swan Sonnenschein and Co., Ltd.).—That any one individual should attempt at the present day to write single-handed a detailed scientific text-book dealing with the whole realm of zoology, and, what is much more, should be capable of doing so in a more or less masterly manner throughout, is little short of marvellous. Nevertheless, this is the gigantic task to which Mr. Sedgwick has committed himself, and the present volume and its predecessor afford convincing proof that he has over-estimated neither his scientific abilities nor his powers of long-continued and close work. Faults and imperfections must of necessity make their appearance in such a work, but the wonder in the present case is not that they are so many, but rather that they are, comparatively speaking, so few. Whether it is really advisable for a single writer to undertake a task of this colossal magnitude, and whether it is not preferable to follow the prevailing fashion of a "symposium" in the making of works of this nature, may be an open question. It is certain, however, that undivided authorship permits of the subject being treated in a much more uniform style than would otherwise be possible, and it ensures that all parts of it are viewed, so to speak, through the same glasses. In the present instance it may be confidently asserted that few, if any, biologists in this country at any rate would be capable of carrying out the task in the manner in which Mr. Sedgwick has so far acquitted himself. That an author can write throughout a work of this description from first hand knowledge is, of course, a manifest impossibility; and in the present volume Mr. Sedgwick candidly acknowledges his indebtedness to several contemporary specialists. For his account of the bony fishes he has, for example, drawn almost exclusively from the recent work of Mr. Boulenger; and critical zoological readers who carefully scrutinize the definitions of the various groups will scarcely fail to detect that they have been drawn up by one who is not an expert on the subject, and that in certain instances they are not absolutely diagnostic.

While the first volume deals with molluscs and the lower invertebrates, the one before us is devoted to the chordata, as restricted by the author; that is to say, the lancelet (miscalled *Amphioxus*) and the vertebrates. In the third volume are to come the ascidians, acorn-worms, echinoderms, and arthropods; while in the fourth and final volume will be discussed the general principles of zoology.

Perhaps the most striking feature of this portion of Mr. Sedgwick's work is the vast amount of information he has managed to convey within the limits of one fair-sized octavo volume; it has, of course, been practicable to effect this only by condensing statements in the greatest possible degree; and this very concentration is of itself a sufficient proof of the enormous amount of labour that has been expended on the task. On the whole, the author is well up to date in his facts, this being especially noticeable in his treatment of the Proboscidea and their apparent relationship to the Sirenia. On the other hand (p. 539), in referring to the marsupial *Myrmecobius* as being allied to the Jurassic mammals, he appears to have overlooked the recent work of Mr. Bensley. In regard to the scheme of classification, we are compelled to differ from the author in many points, notably in regard to the separation of the bony fishes from their enamel-scaled forerunners, and in the refusal to accord to the egg-laying mammals a taxonomic rank higher than that assigned to the various "orders" of the placental group, which, by the way, are more numerous than is admitted by many authorities. Neither do we like to see the mammal-like anomodont reptiles placed between plesiosaurs and chelonians, instead of at one end of the class. To an already fairly long list of corrigenda, the following items may be added: The edentates of S. America do not date from the Lower Eocene or Cretaceous (p. 543). Lipoterna is given throughout in place of Litopterna. *Aglossidæ* (p. 309) is not the family name for the Surinam toad and its relatives. The present reviewer is wrongly credited with having written a book entitled "Deer and their Horns" (p. 588). The statement (p. 599) that whalebone sold for £150 per ton in the early part of the 15th century surely refers to the 18th century. "Style" cannot be expected in a work of this nature, but it is certainly unnecessary to make six consecutive sentences begin with the word "they," as on page 551. Although some of the illustrations are excellent, the less that is said about a large proportion the better.

Despite imperfections, many of which, from the nature of the case, could scarcely have been avoided, the volume is worthy of every commendation, if only as an example of hard and conscientious labour.

Our Stellar Universe: A Road-Book to the Stars, by T. E. Heath, the author of an article appearing in this issue of "KNOWLEDGE," has been received, and will be reviewed in our next number.

Smithsonian Miscellaneous Collections, vol. ii. part 3, has a varied assortment of interesting papers, including "Inquiry into the population of China," by W. W. Rockhill; Seeds of Aneimites," by David White; "The Sculpin and its habits," Theodore Gill; "The Construction of a Vowel Organ," E. W. Scripture; "Habits of a Social Spider," "Fossil Plants," and others.

Graphs for Beginners, by Walter Jamieson (Blackie and Son), 1s. 6d., and **Easy Graphs**, by H. S. Hull, M.A. (Macmillan), 1s., are two little works dealing with the same subject. The first-named treats of graphs from a general point of view, as a means of creating interest, cultivating habits of observation, and stimulating the reasoning powers, rather than as a branch of pure mathematics. The second book is very similar in its general scope, and is also intended for beginners.

Griffin's Catalogue of Scientific Apparatus, in three parts, 1 including Mechanics, Hydrostatics and Pneumatics; 2, Sound, Light and Heat; and 3, Electricity and Magnetism, is a very complete, descriptive list of apparatus useful and necessary to the physicist.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Further Notes on Jupiter's Sixth and Seventh Satellites.

PROFESSOR PERRINE, the discoverer of these two new satellites, has recently published a short *résumé* of their features as at present determined. He makes the interesting suggestion that the large inclinations of the orbits of both satellites to the plane of the planet's equator may be an indication that these bodies have not always belonged to Jupiter, but that they may be captures.

Sixth Satellite.—Owing to its brightness this has been readily photographed in ten minutes with the Crossley reflector, and plates have been obtained on thirty-six nights, the last date of observation being March 22, as the planet is now too near the sun for the satellite to be examined.

A preliminary examination of the orbital elements shows the inclination to the ecliptic and the planet's equator to be about 30°. The period is probably about 250 days, with a mean distance from the primary of about 7,000,000 miles; but it is not yet possible to say with certainty what is the direction of the orbital motion. The actual diameter cannot be measured, but the determinations of brightness indicate a diameter of 100 miles or less.

Seventh Satellite.—A minute examination of negatives of the sixth satellite, taken with the Crossley reflector in 1905, January 2, 3, 4, showed the presence of a much fainter object, which apparently belongs to Jupiter. It was at that time to the N.W. of Jupiter, and had a motion towards the planet.

The many difficulties which presented themselves in determining the true character of the sixth were still greater in the case of this newer one. Being so much fainter, the observations were more difficult to secure, owing to the long exposures required, and its motion was likewise harder to interpret. It was considered, however, that the determinations of February 21 and 22 made it clear that it belonged to Jupiter. The seventh satellite is not shown on the negatives taken during December, 1904, as it was just outside the field then under observation. Definite measures have been secured on the results of 20 nights, the last of which was March 9.

A preliminary investigation shows the orbit to be quite eccentric, the mean distance from Jupiter being about 6,000,000 miles, with a period of about 200 days.

The orbit is inclined to the plane of Jupiter's equator at an angle of about 30°, but the direction of motion is at present uncertain. Its photographic magnitude is estimated to be not greater than the 16th. From this fact and a comparison with the other satellites and the asteroids it is probable that the seventh satellite has a diameter of about 35 miles.

A Probable New Star, R.S. Ophiuchi.

In a special communication from the Harvard College Observatory Professor E. C. Pickering draws attention to further observations of this so-called variable star, which shows certain peculiarities similar to those seen in novæ.

New stars can be distinguished from variables, in many cases, only by their spectra. The usual life of a new star is marked by its sudden appearance where no star is previously known to have existed, and a gradual fading away during which it changes into a gaseous nebula. T Coronæ, Nova Persei, P Cygni, and η Carinæ are instances of varied development.

It is found that on July 15, 1898, the spectrum of the star R.S. Ophiuchi was of the third type, in which the Hydrogen lines $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, $H\zeta$ were bright, and also two lines which appear to coincide with the bright bands in the spectrum of γ Velorum at λ 4656 and λ 4691. This spectrum, therefore, closely resembles that of Nova Sagittarii, and also of Nova Geminorum. A photograph taken on July 14, 1898, confirms the presence of the bright lines, while another taken on August 28, 1894, showed that at that time the spectrum was of Class K, with no evidence of bright lines.

From an examination of the photometric light curve of the star it was noticed that there was a remarkable increase during the year 1898. Before 1891 the magnitude, as determined photographically, was 10·9; it then increased gradually about half a magnitude to 10·4 in 1893, and retained this until 1897. In 1898 it was at first faint (10·8) until May 31. A month later, on June 30, it was 7·7, more than three magnitudes brighter, and after that it decreased regularly about a magnitude a month until October 8, when it again reached the value 10·8. The following year, 1899, it remained faint at 10·6, but in April, 1900, it again brightened to 9·3, diminishing to 10·0 in September of that year. Since then the variations have been only slight.

An examination of several good chart plates shows only one star in this position, and both the spectrum and light curves thus indicate that this object should be regarded as a nova rather than a variable star. In this case its proper designation would be *Nova Ophiuchi No. 3*, the new stars of 1604 and 1848 having also appeared in the same constellation.

Observations of Helium Absorption in the Solar Spectrum.

The number of occasions on which reliable observations have been made of the absorption spectrum of helium in the solar spectrum are so few that considerable importance must be attached to all authenticated instances. Probably the first recorded determination was that by Young on 22nd September, 1870. A few months ago a paper was read before the Royal Astronomical Society by Professor A. Fowler, in which he recorded having distinctly seen the dark D_3 line of Helium in the neighbourhood of the great sunspot of February, 1905.

Quite recently Dr. H. Kreussler, of Berlin, has published an account of two good observations of the phenomenon, obtained on the 12th and 13th June, 1904. The instrument used was a 6-inch reflecting telescope, with a spectroscope magnifying 8 diameters, the slit being in the region of the penumbra of a large spot. It was noticed that the faculæ surrounding the sunspots were very bright on both days.

He suggests that the present appearance of this peculiarity, considered with the above-mentioned observation of Professor Young, appears to indicate that the phenomenon may be characteristic of the period of maximum sunspot activity.

Comet 1905 (a).

The following elliptic elements for the orbit of the Comet 1905 (a) have been determined by Herr A. Wedemeyer from a computation of the observations obtained on March 26 at Nice, and on April 8, 28, at Vienna:—

ELEMENTS.

$$T = 1905 \text{ April } 4{\cdot}0991 \text{ Berlin Mean Time.}$$

$$\left.\begin{array}{l} \omega = 358^\circ\ 13'\ 20''{\cdot}3 \\ \Omega = 157\ \ 23\ \ 27{\cdot}8 \\ i = 40\ \ 14\ \ 38{\cdot}4 \end{array}\right\}\ 1905{\cdot}0$$

$$\begin{array}{l} \log e = 9{\cdot}988506 \\ \log q = 0{\cdot}047307 \\ \log a = 1{\cdot}630354 \\ U = 279 \text{ years.} \end{array}$$

EPHEMERIS FOR 12 H. BERLIN MEAN TIME.

Date.		Right Ascension.			Declination.	
		h.	m.	s.	°	′
July 1	..	13	20	11	+39	44·1
,, 3	..		25	39	39	2·1
,, 5	..		30	58	38	20·0
,, 7	..		36	10	37	37·7
,, 9	..		41	14	36	55·3
,, 11	..	13	46	10	+36	12·9

The New Tenth Satellite of Saturn.

Very little has been published since the discovery of the tenth satellite, but the details are now definitely stated in a communication from the Harvard College Observatory. The satellite was discovered by Professor W. H. Pickering at the Harvard College Observatory during the examination of a series of several photographic plates taken with the 24-inch Bruce telescope, selected from the set used in determining the orbit of Phœbe, the ninth satellite. The new satellite was detected on thirteen of these plates, and the previous announcement of the orbital motion being direct with a period of twenty-one days is confirmed; it is now stated to be nearer Saturn than Hyperion.

Photography of the Canals on Mars.

In a telegraphic communication to Professor E. C. Pickering, Mr. Lowell announces that numerous photographs of several of the dark canals on the planet Mars have recently been obtained at the Lowell Observatory by Mr. Lampland. Amongst others the following are specially mentioned as appearing quite distinctly, some being recognised on as many as twenty negatives: Casius, Vexillium, Thoth, Cerberus, Helicon, Styx, Chaos, Liedeus.

CHEMICAL.

By C. A. MITCHELL, B.A. (Oxon.), F.I.C.

The Action of Light Upon Glass.

SIR WILLIAM CROOKES has communicated to the Royal Society (*Proceedings*, April, 1905) the results of experiments upon specimens of coloured glass sent to him by correspondents in Bolivia and Chili. The pieces of glass, which had originally been white, ranged in colour from pale amethyst to deep violet black, and the colour was not superficial but permeated the whole substance. It could be destroyed by heating the glass until it became soft, and restored again by exposure to the rays of radium. Manganese was found to be present in each case, and as the glass had been exposed to direct sunlight at an altitude of 4000 metres above the sea, Sir William concluded that it was possible that at that height there might be specially active rays in the sunlight which would convert the manganese present into the violet coloured manganic silicate. In his opinion the colour produced in glass by radium was the same as that caused by long exposure to the sun's rays. In the discussion Professor Judd called attention to the fact that the glass in some of the old greenhouses in Kew had changed from its original green colour (due to iron oxide), and after becoming colourless had gradually turned violet, and he attributed this to the manganese in the glass. It is interesting to note that Faraday, in 1825, recorded the occurrence of similar colorations in the windows of certain houses, now pulled down, in Blackfriars Road, after nine months' exposure to sunlight. Mr. W. H. Low, in a letter to the *Chemical News*, reports that he has observed numerous instances of the same kind in old window glass in many of the houses in Boston, U.S.A., the colours ranging from pink to violet and almost blue. The houses face east and are in low situations, so that the altitude cannot be one of the factors in this case. He asserts that a regular gradation in colour can be produced by covering successive portions of window glass with black paper and allowing each uncovered portion to be exposed to sunlight for a month longer than the preceding portion. Herr F. Fischer has also made experiments as to the influence of the light from an incandescent mercury lamp of special construction, the rays from which he concludes to be those of ultra-violet light. Of the eight kinds of glass tried, four, including a German lead glass and an English lead glass, were outwardly unchanged, while four were coloured a decided violet within 12 hours, the coloration becoming visible after 15 minutes. All of these contained manganese, whereas the uncoloured four were nearly free from compounds of that metal. Heat destroyed the colour, but it could be restored by a fresh exposure to the light. When the glass was covered with thin sheets of mica no coloration was produced, and it was therefore concluded that the effect was due to radiations of short wave length. Herr Fischer also suggests that the violet colours produced in glass by Röntgen tubes may be due to ultra-violet light acting on the manganese in the glass, and that the similar effect caused by radium may also be connected with radiations of short wave length.

The Prevention of Poisoning by Mercury Vapour.

The workmen in the quicksilver mines and, to a less extent, those engaged in the manufacture of barometers and other instruments in which mercury is used, are liable to suffer from a peculiar form of poisoning produced by continually breathing mercury vapour. The disease, which is known as "the trembles," or "mercurial tremor," affects the nervous system, so that the sufferer is attacked by fits of trembling whenever any attempt is made to use the muscles, and it eventually ends in death. In the mines in Spain, Austria, and America it is usual to remove workmen to other parts of the works comparatively free from the vapour, so soon as they show the characteristic signs of poisoning; but the Spaniards in South America did not pay even this amount of attention to their miners. A mining community was founded towards the close of the 16th century at Huancavelica, in Peru, to work the celebrated mine of St. Barbara, in which is a subterranean village with a church cut out of the cinnabar. This mine was a great source of profit to the Spanish, and it is estimated that during their rule thousands of the Indians driven to work there died of mercury poisoning. No serious attempt appears to have been made to grapple with this evil except that in certain mines better systems of ventilation have been adopted, and it has been left to an Italian chemist to devise a simple means of prevention. Dr. Tarugi has found that aluminium in a finely-divided state immediately absorbs mercury even when only traces of the metal are present in a large volume of air. The amalgam produced is very stable, and can be heated to 200° C., or twice the temperature of boiling water, without losing the slightest trace of mercury. This absorptive power of aluminium is so great that the reaction can be used as an extremely sensitive test for mercury. In order to utilise this property of aluminium in the prevention of mercury poisoning, Dr. Tarugi has devised a respirator containing several layers of very fine aluminium gauze, which will allow the air to pass whilst retaining every trace of mercury vapour. This respirator has been patented in Italy, Austria, and Spain, and will probably before long be adopted in all quicksilver mines.

The Consumption of Odoriferous Constituents by Plants.

The results of interesting experiments on basil plants have been published by MM. Charabot and Hébert. One set of plants were kept in the dark for six weeks and another under normal conditions for the same period. The amounts of essential oils (to which the perfume is due) were determined before and after the experiments, and it was found that they had increased twenty-fold in the plants kept under ordinary conditions, while there was a notable decrease in the case of the plants kept in the dark. Hence it appears that the odoriferous constituents of basil are not simply products of excretion, but that under certain conditions they can be utilised to supply some of the energy not given by the light or to form tissue.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Coal.

THE Report of the Royal Commission on Coal Supplies has served to emphasize one fact very clearly, namely, that in spite of all fears which have possessed the British people for forty years as to the possible exhaustion of our coalfields, such fears have very little reason for their existence, and at least for half a millennium, even with the present rate of consumption, there will be no shortage of supply. We are, in fact, only just at the beginning of the "coal-using age." In 1820 Britain raised but 20 millions of tons of coal. Now she raises 230 million tons a year. If she continue to use coal to

the same extent as now, she has five centuries before her, and during this period it may safely be said that no one will feel the gradual exhaustion which will be taking place. But the Commissioners point out in their report what other thoughtful men have pointed out before, that other considerations will come into play which will probably have the effect of reducing the rate of increase of output, until finally the immense existing output will actually decline. Not improbably by the time that our coal supplies are approaching exhaustion, the greater portion of the demand will have ceased, and other means of lighting and heating will exist other than that to be obtained from coal.

Foreign Coal.

When we look at deposits of coal which are found abroad we may be fairly astounded at the wealth which some continental countries possess, and it is as well that there should be a clear understanding that the foreign supplies of coal bear much the same proportion to our British supplies as an elephant does to a mouse. No human agency can ever exhaust the world's supplies. But frequently they are so situated as to be practically valueless. They are in a similar category to what the Commissioners called the "unproved" coalfields of Britain, and the seams at depths greater than 4000 feet, below which no mine is known to exist. China has rich possessions of coal. Many of the seams are near centres of population, and are easily worked. In the mountainous areas of western China coal-measures are found in great profusion, and seams from 30 feet thick and upward have been traced in a horizontal plane for 200 miles towards the Mongolian frontier. But at present they are practically valueless, and, like our own deep-lying seams, require engineering skill such as is not now to be found for their development.

The Age of Diplodocus.

At the official presentation to the Natural History Museum of the replica of *Diplodocus Carnegii*, the curator of the Carnegie Museum was reported to have alluded to the age of the monster Dinosaur as four thousand centuries. English geologists do not as a rule care to speak of the age of any particular formation or fossil in terms of years. Years are such insignificant items where geological ages are concerned, and every estimate so made is certain to be open to very great error. But it is impossible to conceive by what means of calculation a creature of Jurassic age can be said to be but 400,000 years old. Geologists have for years fretted under the reign of those physicists who say that no form of life was possible on this earth before 100 millions of years ago. And in view of possible discoveries in connection with radio-active bodies in the future, it becomes increasingly difficult to place a period either to the time at which the sun began to give out heat, or when it will cease to do so. Geologists will, I am convinced, find themselves compelled to tear themselves away from all restrictions of time placed upon them by those who are first physicists and after geologists. The more the facts of geology are borne in upon one, the more, as it seems to me, is it impossible to see the possibility of all the great geological phenomena having taken place in less than 250 millions of years. By a process of calculation on this basis, the age of the *Diplodocus*, namely, the Jurassic age, came to a close 41½ millions of years ago. This is, however, only an estimate; but it is likely to be nearer the truth than the utterly insufficient number of years previously given.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Habits of the Kagu.

THE Kagu (*Rhinochætus jubatus*) is one of those rare and aberrant types which seems likely to disappear from off the face of the earth, leaving but little save its skin and a few particulars of its anatomy for the ornithologist of the future to remember it by. Though a native of New Caledonia, according to some, its nearest ally is the equally rare and unknown Mesites or Madagascar Kagu, while others regard it as more nearly related to the Sun-bird (*Eurypga helias*) of South America. This, too, is an aberrant type.

All that appears to be known of its eggs and nesting habits we owe to observations made on a pair of these birds in captivity and recorded in the current number of the *Emu*. A pair, kept in an aviary at Sydney, built a nest of a few coarse sticks and leaves, in which was laid a single egg. This was then surrounded by more sticks and brooded continually by the cock bird, relieved occasionally, it is believed, and during the night, by the female. Incubation lasts five weeks. If the egg be removed, another is laid, and this will be replaced, if taken away, two or three times. The egg is here described as bearing a striking resemblance to that of a gull, from which it differed only in the fine texture of the shell.

This is curious, inasmuch as an egg dropped by one of these birds in the Zoological Gardens in London, and now in the British Museum, bears as close a resemblance to that of the Southern Courlan (*Aramus scolopaceus*), being perfectly elliptical in shape, cream-coloured, spotted and blotched with dark brown and purplish grey. It differs from the Courlan's egg, however, in being without gloss, and slightly rough in texture.

The Hunting Tactics of the Sea Eagle.

A writer in the *Field* (June 17) gives a short but interesting account of his observations on the habits of the white-tailed Sea Eagle (*Haliætus albicilla*) in Greenland. In summer its principal food is salmon, varied by sea-birds common along the inlets. In autumn, when the salmon have ascended to the lakes, the birds resort to the sea. They appear to have a special fondness for eider duck, which are taken by strategy. "Stationed near the water in a commanding position, with a background of cliff, the colour of which assimilates with that of the eagle's plumage, he sits motionless, until a flock of duck settles near him. After a time one or two dive in search of food, but not until all have gone under together does the eagle make a sign. He then glides swiftly to the spot, and circles over it close to the water; with his sharp eye he can detect the birds before they reach the surface. At first he is not usually successful, for as soon as they become aware of the presence of the enemy, they dive again instantly; but in time they are obliged to come up for air, and then one of them becomes an easy victim." A full-grown eider drake is easily lifted up and borne away in the talons of this powerful pirate. Most of the sea-fowl, it is interesting to note, readily distinguish between the Sea-Eagle and the falcon when on the wing and vary their tactics, and escape capture accordingly. Thus, when pursued by the falcon they dive, but in fleeing from the eagle they depend on their ability to turn rapidly on the wing, which the eagle is unable to do.

Golden Orioles in Stratford.

Mr. Reginald Hudson, in *Nature Notes* for June, records the fact that a pair of Golden Orioles were seen in a garden on April 27, at Shottery. Whether they have so far been allowed to remain unmolested, we cannot say; if they have, in all probability they will nest here. As many readers are doubtless aware, the Golden Oriole has more than once reared its young in these islands, and were they not so mercilessly shot down on every occasion, these gorgeous birds would doubtless more frequently visit us.

Iceland Gull in the Moy Estuary.

Mr. R. Warren, in a somewhat sarcastic note in the *Irish Naturalist* for June, records the fact that an immature Iceland Gull, *Larus leucopterus*, was shot by himself in the Moy Estuary on April 26. He gives the following measurements:—Length, 21½ ins.; capus, 16 ins.; tarsus, 2 ins.

Tufted Duck Breeding in Co. Mayo.

According to the *Field* (June 17): Three or four pairs of Tufted Ducks, *Fuligula cristata*, appear to be breeding this year on Lough Conn, where a nest of eleven eggs was seen by Mr. S. Scroope. The nest was identified by a piece of down sent by the Editor of the *Field* to Mr. Whittaker, of Rainworth. Thus the extended breeding range of this bird in Ireland, to which Mr. Ussher has drawn attention (*Birds of Ireland*), is confirmed. In the volume just referred to, it is stated that the portions of Ireland where this bird is not known to breed include, amongst others, "the province of Connaught west of the Shannon, and Lough Arrow, in Sligo." Lough Conn lies a little less than 30 miles from Lough Arrow.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Ether Drift.

The question as to whether or not the earth carries the *ether* near it in its journey through space is one of very great theoretical importance, and the last word upon it has not yet been said. The fact that stellar aberration has the same value whether determined by means of an ordinary telescope or by one filled with water can most simply be explained by supposing that *in the water* the ether is carried forward with a portion only of the earth's velocity, while in the air round the telescope it is sensibly at rest in space.

On the other hand, the results of Michelson's and Morley's experiments with their interferometer can be accounted for most simply by supposing that both the earth and the ether near it are moving with the same speed; that is to say, that the earth drags the surrounding ether with it in much the same way as that by which a layer of air is carried by a projectile.

Experiments by Sir O. Lodge on whirling massive discs prove that they at any rate exert no perceptible drag; and, consequently, if the earth does so, it must be due to its great magnitude. It was pointed out by FitzGerald (and independently by Lorentz) that if we suppose that the length of a body when set moving is shortened in the direction of that motion then Michelson and Morley's experiments do not imply the absence of relative motion; in fact, if the shortening takes place to an appropriate extent, they do not show that the ether is moved at all. Other experiments have also been made which seem to require that this supposed shortening is real.

Morley has recently (*Philosophical Magazine*, May, 1905) varied his previous investigation with the object of testing whether the compensation which cancels the effect due to relative motion is complete in every case. It is the shrinkage of the base plate of his apparatus which may come into play; and, besides improving the apparatus by increasing the sensitiveness, he has changed the material of this plate from iron to wood. There is still absence of any indication of relative motion of earth and ether, and the proportional shortening must therefore be the same as in the previous experiments.

It may at first sight seem unlikely that two such different materials should be equally affected. But the true explanation must be that it is not the nature of the molecule (or molecular aggregate) or even that of the chemical atom which determines it, for these are very different in the two cases. It is something more fine grained than these, and this something must be essentially identical (at any rate as far as this particular property goes) in both these bodies. In fact, the result is an additional piece of evidence in favour of the theory that all atoms are built up of smaller particles, each one of which is of the same kind.

A New Interrupter.

Workers with induction coils know too well the trouble there is with the interrupter, whatever its type. The difficulty is to a very large extent removed in the Grisson Resonance Apparatus which is put on the market by Messrs. Isenthal and Co. The intermittence of the current in the primary coil is produced by means of a modified commutator which is spun round by a ¼ H.P. electric motor. The commutator interchanges, with a frequency up to 200 times a second, the connections of the armatures of a condenser with the primary coil and battery (or other unidirectional source) which are in series with it. At each reversal the battery sends through the coil a quantity of electricity equal to twice the maximum charge of the condenser, and these impulses must always go the same way through the primary. Since the current into the condenser rises very fast owing to the small inductance of the primary and then falls off much more gradually, the quantity that flows through the secondary is nearly, if not perfectly, unidirectional and hence is suitable for exciting X-ray bulbs. The essential reason of the efficiency of the commutation arises from the fact that the reversal takes place when the current into the condenser is zero, or at any rate very small; in consequence there is absolutely no visible sparking at it. This is the case through the whole working range of speed, for it is at most the tail end only of the flow that is cut off.

Instead of commutating the condenser it may be the battery that is so treated. The flow through the primary is then alternately of opposite signs, and the flow through the secondary is also alternating. In this case by suitably choosing the inductances, the condition of resonance may be set up at particular speeds. In fact, by this means from the primary circuit alone, an e.m.f. of much higher than 100 volts can be obtained by the use of a 100-volt circuit.

The condensers employed are electrolytic condensers consisting of aluminium plates immersed in an electrolyte contained in a seamless steel vessel. Each of these is capable of furnishing a current of 15 amperes from a 110-volt lighting circuit. Greater currents can be obtained by connecting a number in parallel. Such condensers are very compact, the dielectric being the thin film of aluminium oxide which forms on the plates.

When the coil is replaced by a suitably wound electromagnet a powerful alternating magnetic field is produced which acts on the nervous system. If the forehead is placed close to one of its poles a flickering sensation of light is experienced.

The spinning commutator is made in a thoroughly workmanlike way; its design is of an engineering type contrary to what is only too frequently turned out by instrument makers.

ZOOLOGICAL.

By R. Lydekker.

The Smallest British Dinosaur.

The Dinosaurian reptiles—both small and great—appear to be attracting a considerable amount of attention at the present time. One of the latest contributions to the literature of the subject is a note in the May number of the *Geological Magazine*, by Baron Francis Nopcsa, on the skull of *Hypsilophodon*, a species from the Wealden of the Isle of Wight, of about the size of a fox, and if not actually the most diminutive, at all events one of the smallest representatives of the group. Despite its diminutive size, it appears to have walked on its hind legs after the fashion of its gigantic cousin, the iguanodon, of the same epoch. In a specimen preserved in the British Museum, Baron Nopcsa shows that what had been taken for the skull of the creature is really its lower jaw, and that the structures described as bony plates from the white of the eye are really the teeth. Consequently, there is every reason to believe that all dinosaurs, like their relatives, the crocodiles, lacked a ring of bony plates in the white of the eye.

The English Water-Shrew.

Captain Barrett-Hamilton, in a recent issue of the *Annals and Magazine of Natural History*, points out that the British representative of the water-shrew differs from the typical continental form of that animal to an extent sufficient to permit it to rank as a distinct local race, for which the name *Neomys fodiens ciliatus* is available. There are likewise several continental races of the species, the Scandinavian, and other mountain forms, in common with the one from the British Islands, being dull-coloured creatures, in comparison with those inhabiting the lowlands.

Face-gland Vestiges in the Horse.

In a paper published in the May number of the *Annals and Magazine of Natural History*, Mr. R. I. Pocock considers that the depression so frequently found in the skulls of Arab horses and thoroughbreds, immediately in front of the eye, has nothing to do with the face-gland of the extinct hipparions, but is merely for muscular attachment. If this be so, the theory as to the importance of this depression in regard to the origin of Arabs and thoroughbreds is wiped out at one stroke. Despite the fact that the existence of functional face-glands has been recorded in two living horses, the author considers himself justified in stating that the modern horse never exhibits any trace of the hipparion's face-gland.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Intensification with Chromium Salts.—The method of intensification referred to in the "Science Year Book" as having been recently suggested by Mr. J. S. Teape and by Messrs. Welborne Piper and D. J. Carnegie, has been further examined by the latter gentlemen. The process consists in rehalogenising the silver image by means of a solution of potassium bichromate containing hydrochloric acid, and then reducing the silver salt formed with a developer. The apparently anomalous result that the image is so made much more dense is due, as might have been anticipated, to the deposition of a chromium compound, produced doubtless by the reduction of the chromate by the metallic silver. This is a clear guide to the precautions that are necessary to ensure success, and accounts for the very different results that different formulæ give—from nothing up to a very large gain in density. Messrs. Piper and Carnegie in their last communication ("Amateur Photographer," XLI., 453) recommend potassium bichromate 10 grains, hydrochloric acid (s.g. 1.16) 5 minims, and water to one ounce, as the most generally useful bleaching solution, an increase in acid diminishing the increase of density, and a smaller quantity (preferably with dilution of the solution) increasing it. Amidol is preferred to other developers because it is rapid in action and needs little or no alkali.

The authors consider this process far preferable to any mercury process, including even the mercury and ferrous oxalate method. Here I must join issue with them, and for two distinct reasons, either of which would, in my opinion, be sufficient to establish the superiority of the mercury and ferrous oxalate method. In the first place, the chromium compound that is added to the image is soluble in acids and is produced always in an acid solution. So far as at present known, the presence of a solvent of the material that constitutes the image renders the production of the image uncertain. That is, one cannot be sure of the same increase of density following the same procedure so far as one is able to make it the same; and one can never be sure that the presence of the solvent does not lead to a reduction effect on the image, and if it should do so it is scarcely possible for it to be proportional throughout. The mercury and ammonia method has a solvent present, namely, the ammonia, and this method never gives a proportional result. Then, secondly, the material added to the image has a "brownish buff" colour, according to the authors, and this is very much the colour that one would expect the chromium compound to be. It is always undesirable to introduce a coloured substance into a negative, because a coloured image will produce different results according to the colour sensitiveness of the printing paper, and also, it may be added, according to the nature of the light used. A neutral tinted image graduates all lights alike, but it is practically impossible to calculate the effect of a coloured image. Therefore it seems to me that while other methods have advantages in special cases and are good enough for negatives that have no particular value, the mercury and ferrous oxalate still remains the only scientifically reliable method of intensification.

Reduction with Cobaltic Salts.—Mr. Harry E. Smith (Jour. Royal Phot. Soc., May, p. 185) has been experimenting with certain ammonio-cobaltic salts and analogous compounds as reducers for negatives and silver prints, and finds that the tetra-ammonio-cobaltic potassium nitrite, a salt prepared by Erdmann a generation or so ago, is the most satisfactory of those he has tried. Erdmann's salt will shortly be on the photographic market, its use as a reducer having been patented. The formula suggested is a quarter per cent. solution of the salt in a seven or eight per cent. solution of sulphuric acid, and the negative or print after reduction is soaked for three minutes in a ten per cent. ammonia solution, and finally washed. Mr. Smith claims for this reducer that it attacks the "denser deposits of silver much more readily than the half-tone and lighter deposits, so that it is particularly useful in softening the scale of gradation of hard negatives or prints." It appears to be distinctly slow in action. From Mr. Smith's communication it is not clear whether what he calls its "selective" action, that is, the fact that it does not attack the thinner deposits unduly as most reducers are liable to do, is due simply to the slowness of the action or to some peculiar property wherein it may be likened to the persulphates. If the latter is the case, then an investigation of the chemistry of the change during reduction may be of considerable interest as helping to show why the persulphates produce exceptional results, for we do not yet know what the action of the persulphates is from a chemical point of view. I consider that in all cases we ought to know the chemistry of such changes as these before trusting valuable negatives to the action of the proposed reagents. Of course, negatives that have no permanent value do not require such consideration. I hope that Mr. Smith will give us the results of further investigation, and determine the character of the brownish substance that is sometimes obvious after reduction, and for the removal of which the ammonia bath is desirable.

The Stability of Photographs.—The action of light and air upon photographs is often regarded from a too empirical point of view, its effect being judged of merely by the visible change that results. Light, in some cases, causes a loss of colour or bleaching, as in the fading of dyes that is so obvious in curtains, carpets, clothes, and dyed fabrics in general; and in others a production of colour as in some methods of photographic printing. If the simple object is either to bleach or to produce colour, then, of course, the observation of the colour-change may be a sufficient guide to the progress of the action, but if the aim is to test for stability, neither the presence nor the absence of a visible change is sufficient to justify any definite conclusion. There may be even much alteration in appearance while the image remains unaffected, as in the case of platinum prints carelessly made or pasted on to inferior mounts; and on the other hand, there may be considerable change that is not manifested by any notable alteration in either tint or depth of colour. The only way to settle such questions is to investigate the composition of the image by chemical means as well as its appearance by optical means.

Correspondence.—Bryan, E. H.—The method of development you propose would not be advantageous for several reasons. The practical aspects of photography during the visit of the British Association to South Africa will be dealt with in the special number of this journal that will shortly be issued.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Royal Microscopical Society.

May 17th.—At 20, Hanover Square. Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Mr. Rousselet described an old microscope of the Culpeper-Scarlet type which had been presented to the Society by Mr. J. E. Hazelwood. It was signed "Nath. Adams, Optician to his Royal Highness Frederick Prince of Wales Fecit." The date was probably about 1740, and it differed from others of the type in having four pillars instead of the usual three. Mr. Rousselet also described an old Adams Lucernal microscope, made by Adams' successors, W. and S. Jones, which had been presented to the Society in January by Lieut.-Col. Tupman, and was exhibited in the room. The body consisted of a mahogany box of the form of a frustum of a pyramid about 17 ins. long and 7 ins. square at the base lying horizontally. The objective was carried in a sliding tube at the small end, and an eye-piece of two lenses about 5 ins. in diameter was placed at the other end. The stage had vertical and horizontal motions, and there was a condensing system of two independent lenses behind it. The curious feature about the instrument was the method of observing the image, which was by means of an aperture about ¼ in. in diameter in a small disc carried by an arm that was attached to a telescopic rod projecting from below the instrument. The distance of the disc from the eye-piece could thus be adjusted until the best effect was obtained. On looking through the disc, which in this instance was about 14 ins. from the eye-piece, a very fair image of an object placed on the stage was seen in the eye lens. A communication received from Mr. D. D. Jackson, of New York, on "The Movements of Diatoms and other Microscopic Plants," was read. Mr. Jackson described the interesting observations and ingenious experiments made by him, some with artificial diatoms, which led him to conclude that the movements referred to are caused by the escape of oxygen gas evolved in these organisms. Slides of Oribatidae were exhibited from the collection presented to the Society some twenty years ago by Mr. A. D. Michael, who, on the invitation of the President, made some remarks upon that family of the Acarina.

The Microscope in the Witness Box.

The use of the microscope as an aid to the scientific worker is apparent to everyone, and it is, of course, universally used in scientific laboratories. It will occur to most people that it must have many uses as a means of detecting adulteration in food, and that, therefore, it is a valuable aid to the public analyst, but it is, perhaps, not so evident that it can give equally valuable help and testimony in the witness box. An elementary example of the help given by the microscope in forensic medicine is its use in detecting blood stains. The minute red blood discs which give the red colour to the human blood are not more than seven one-thousandths of a millimetre in diameter, and are obviously microscopic objects, while they can only be seen in undried blood, but the microscope can be used to give evidence of blood stains in quite another way. Suspected blood stains on clothing, etc., can be treated with a little alkali, evaporated to dryness, and then heated with acetic acid and a minute amount of sodium chloride, with the result that small but characteristic crystals,

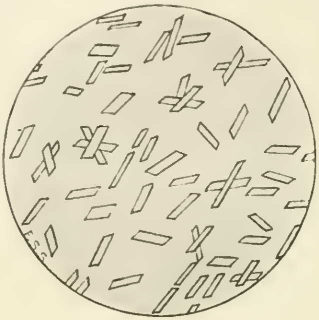


Fig. 1.

known as "haemin crystals," make their appearance. (Fig. 1, much magnified.)

This, however, is more an example of laboratory work than of a demonstration in open court, but some very striking examples of what can be shown by the microscope in cases of suspected forgery were given by Mr. Albert S. Osborn a year and a half ago, in what was unfortunately the last number of the American *Journal of Applied Microscopy*, and I reproduce some of his excellent illustrations here because they will, I think, interest readers in this country who have not seen the original paper, expressing my obligations to Mr. Osborn for both illustrations and subject matter.

For instance, as Mr. Osborn points out, it is manifest that if a paper were folded, and it could be demonstrated that part of the writing was made after such folding, strong suspicion would be cast upon the document. This might be shown by a tiny amount of ink spreading into the crease and even reaching the other side of the paper, and it would be quite unmistakable.

Fig. 2.

Similarly, fraudulent additions to documents may be shown to have been written with a different pen, or at a different time, or under different conditions, by measuring the width of the unshaded strokes and observing that they differ from those of the original writing. Such measurements are readily made up to the ten-thousandth of an inch, or less.

Still more striking are additions made to letters as in Fig. 2, where the numeral 1 in 11 has been changed into 7 by the addition of a stroke at the top.

A fraudulent addition or interlineation may touch the top of another letter and thus give evidence against itself. In Fig. 3 it will be seen that the words "in full

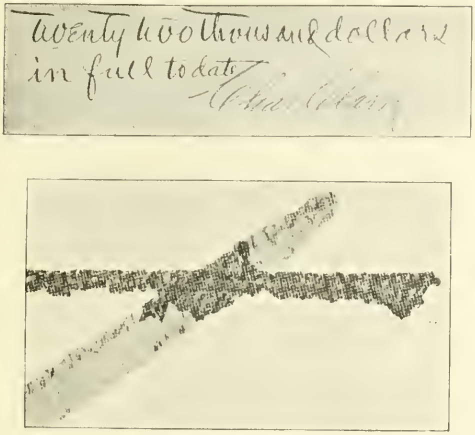


Fig. 3.

to date" have been manifestly added after the signature of the receipt, as shown by the crossing of the "t" in "date" running over and into the top of the initial letter of the signature. In this case the whole question was whether the receipt was given for a definite amount or "in full to date."

Forged signatures are frequently first carefully outlined in pencil before being inked in. In such cases the pencil marks can be shown under the microscope not properly covered, and with the graphite caught in the ink film. Any further attempt to erase the pencil marks would probably have more or less altered the superficial appearance of the paper. Forged signatures carefully and laboriously drawn from a model with frequent liftings or stoppings of the pen show the over-lapping of lines and uneven distribution of the ink with astonishing clearness. The tint also of the ink may show on comparison that a document purporting to be several years old is really only as many days old. Even in typewriting, comparisons by means of the microscope may show numerous discrepancies and differences.

Perforations are often used to prevent fraud, but these have been known to be laboriously filled in and new ones made. The microscope, however, readily exposes such a fraud, as is shown in Fig. 4.

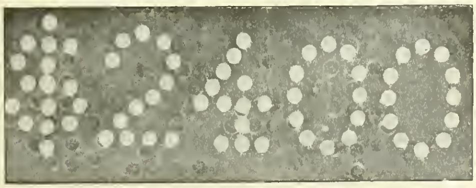


Fig. 4.

Mr. Osborn calls attention to the fact that high powers are not necessary to detect the majority of such cases of alteration of documents. A $\frac{1}{6}$ in. is about as high a power as is needed, but there must be good substage illumination by means of a condenser, and means of illuminating opaque objects by a bull's-eye or otherwise. Polarizing prisms may be useful in certain cases of paper fibre examination, and micrometer apparatus is essential, as well as drawing apparatus. Photo-micrography is of most valuable service in making exact reproductions.

The microscope should have a large stage, and for examining some kinds of disputed documents the microscope tube may be mounted with advantage on a special stand without a stage, so as to give a large open field directly under the objective. In this way it is easy to examine the middle or any other part of a large document. The examination of crossed lines, traces of pencil marks, edges of lines, paper fibres, etc.; the investigation of evidences of re-touching, and the examination of ink conditions may require a high power objective, but for examining writing as such a magnification of from ten to fifty diameters is ample. Photo-micrographs are frequently useful, and may, in certain cases, be conclusive evidence. The general magnification of such photo-micrographs is from twenty to fifty diameters, but the objective must be flat in the field and a long camera length is preferable to eye-piecing. A camera lucida attachment for drawing directly from the image in the microscope is useful for making illustrations and outlines, and in measuring.

Objectives with Safety Springs.

Beginners and elementary students find the very short working distance of high power objectives a source of danger either to the front lens of the objective or to the cover-glass of the slide, and even more experienced workers are sometimes liable to misfortunes of this nature. To obviate this C. Reichert has fitted Bourgnet's Spring Safety Action to all his high power objectives from $\frac{1}{6}$ in. upwards. The optical part of the objective is mounted in such a way as to slide bodily within an outer projecting case, the front lens projecting through a circular aperture in the front of this case and kept in position by a spiral spring above, which rests against a collar inside. Under ordinary circumstances the elasticity of this spring keeps the objective in proper adjustment, but in case of contact between lens and cover-glass the optical part is pushed into its sheath.

Hanging Drop Preparations.

Mr. J. R. Collins gives in the *British Medical Journal* a very simple method of making a hanging-drop preparation which obviates the usual method of building up a moist cell with rings of wet blotting-paper. A small rubber elastic band of suitable size and thickness is smeared with vaseline on one side, and this side is then placed on the slide. The upper side of the rubber band is now likewise smeared with vaseline and the cover-glass with its hanging-drop applied to it. An air-tight cell is thus easily made.

[*Communications and enquiries on Microscopical matters are invited and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for July.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 3.48, and sets at 8.18; on the 31st he rises at 4.23, and sets at 7.40.

The earth is at its greatest distance from the Sun on the 3rd, when the apparent diameter of the Sun is a minimum, being 31′ 30″·7.

Solar activity is well shown by the large number of sunspots and bright prominences.

The position of the Sun's axis and equator, required for physical observations of the Sun, is indicated in the following table:—

Date.	Axis inclined from N point	Equator S. of Centre of disc.
July 1 ..	2° 43′ W.	3° 3′
,, 10 ..	1 23′ E.	4 0
,, 2[illegible] ..	5 51 E	4° 56′
,, [illegible] ..	10° [illegible]′ E.	5° 45′

The Moon:—

Date.	Phases.	H. M.
July [illegible] ..	● New Moon	5 50 p.m.
,, [illegible] ..	First Quarter	5 46 p.m.
,, 1[illegible] ..	Full Moon	[illegible] 32 p.m
,, 2[illegible] ..	Last Quarter	1 9 p.m.
July 1[illegible] ..	Perigee 229,[illegible] miles	5 0 a.m.
,, [illegible] ..	Apogee 251,[illegible] ,,	[illegible] 30 p.m.

Occultations.—There are no stars brighter than the 6th magnitude occulted during this month, as seen from Greenwich.

The Planets.—Mercury is an evening star in Gemini and Cancer, but is not favourably situated for observation during the early part of the month; towards the end of the month he is approaching an eastern elongation from the Sun, but even then he only sets one hour after sunset.

Venus is a bright object in the morning sky, looking east, rising about 1.10 a.m. on the 15th; as seen in the telescope the phase appears that of "half moon," the apparent diameter of the disc being 22″. Towards the end of the month the planet is skirting the northern boundary of the Hyades.

Mars is on the meridian just before sunset, but on account of increasing distance from the earth his lustre is diminishing. The planet is not well placed for observation on account of his great southerly declination, and as this is increasing his meridian altitude is becoming less. The apparent diameter of the planet is 12″ and the disc is slightly gibbous, [illegible] being illuminated. On the 15th the planet sets about [illegible] p.m.

Jupiter is a morning star in Taurus, and is situated a few degrees south of the Pleiades; on the 22nd he rises about midnight. On the 3rd and 4th, Jupiter and Venus will form a brilliant pair in the morning sky, being less than [illegible] apart, Jupiter being to the north. The apparent polar diameter of the planet is 33″.

Saturn is coming into a more suitable position for observation in the evenings; he rises about 10.50 p.m. on the 1st and about 8.40 p.m. on the 31st. Near the middle of the month the planet is on the meridian about 2.40 a.m.; he is describing a short retrograde path near σ Aquarii.

We are looking down on the northern surface of the ring at an angle of 9°, and the apparent diameters of the outer major and minor axes are 43″ and 6″·5 respectively, whilst the polar diameter of the ball is 17″·0.

Uranus is becoming more favourably situated for observation at convenient times, being on the meridian about 10.30 p.m. on the 15th. He is situated about 2½° south of 4th magnitude star μ Sagittarii, and can easily be seen with an opera glass, though somewhat difficult to see with the naked eye.

Neptune is out of range for observation.

Meteors.—The most conspicuous shower is the δ Aquarids, which occurs on the 28th; they are slow moving and long. The radiant is situated in R.A. XXII.^{h} 6^{m}, Dec. S. 11°.

Telescopic Objects:—

Double Stars.—5 Serpentis, XV.^{h} 13^{m}, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^{m}, N. 15° 44′, mags. 3·8, 10; separation 31″.

θ Serpentis, XVIII.^{h} 51^{m}, N. 4° 4′, mags. 4·0, 4·2; separation 21″·6. Both are yellow, the primary being of a paler yellow than the smaller star.

ξ Cephei XXII.^{h} 1^{m}, N. 64° 8′, mags. 4·7, 7; separation 6″.

δ Cephei XXII.^{h} 26^{m}, N. 57° 56′, mags. 4·2, 7; separation 40″. A pretty pair for small telescopes, yellow and blue. It is also a variable star; period 5^{d} 9^{h}, with a quick rise to maximum in 1^{d} 9^{h}.

Clusters.—M5 (Libra). A compact cluster situated about one-third of a degree north of the double star 5 Serpentis; when seen through a pair of opera glasses it appears like a large nebulous star.

N.G.C. 6633. Cluster in Serpens. About one-third of the way between θ Serpentis and α Ophiuchi (visible to the naked eye).

New Preservative for Animal Products.

Mr. Fletcher, chemist and analyst of Sydney, New South Wales, has during recent years introduced a new process for preserving meats and other organic substances. The food products are placed in an airtight chamber, and treated by a gas for six or eight hours. No liquids or solids come into actual contact with the meat. An unskilled workman can operate the chamber, and the cost is said to be very small. It is further alleged that no taste from the curing process has yet been noticed, and no analyst has discovered any preservative whatever in the goods cured. Beef up to the present has not been cured satisfactorily, and the process is not effectual with fruit or milk, but success is claimed for the treatment of mutton, bacon, sausages, &c. The treatment is simple and rapid. No freezing is necessary, and no borax or kindred preservatives, and it is stated that food after treatment can be shipped in safety and remain in a fresh condition during transport. Since the latter part of 1902 it is stated that the process has been tested continuously, and that meat, sausages, &c., cured by it in April, 1903, are still sound and good.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

CONTENTS AND NOTICES.—See page V.

THE BRITISH ASSOCIATION.

MEETING IN SOUTH AFRICA.

Professor George Howard Darwin, who, on August 15, at Cape Town, will be installed President of the British Association for the Advancement of Science, in succession to the Right Hon. A. J. Balfour, M.P., is the second son of the late Charles Robert Darwin, the eminent naturalist—the "Copernicus of biology." Born in 1845, at Down, the Kentish home of the Darwins, he entered Trinity College, Cambridge, and in 1868 he graduated as Second Wrangler and Second Smith's Prizeman. In the same year he was elected Fellow of his College, and in 1883 was elected to the Plumian Professorship of Astronomy and Experimental Philosophy in the University of Cambridge, vacant by the death of the Rev. James Challis, M.A., F.R.S., a position which he still holds.

Photo by Maull & Fox.]

PROF. G. H. DARWIN, LL.D., F.R.S., President.

One of the earliest of Professor Darwin's contributions to science appeared in the "Philosophical Transactions" entitled "On the Influence of Geological Changes on the Earth's Axis of Rotation"; his most recent was read before the Royal Society on May 18—"On Lesage's Theory of Gravitation and the Repulsion of Light." In a series of papers he has dealt exhaustively with the theory and prediction of the tides, especially with reference to Indian tidal observational work. The trend of his studies will, however, be manifest in his Presidential Address. This will discuss the general principles involved in theories of evolution, with special reference to the world of inanimate matter, and will be illustrated by means of various theories of the intimate constitution of matter and of cosmical evolution.

Professor Darwin has been honoured by many scientific societies both at home and abroad. In 1879 he was elected a Fellow of the Royal Society, receiving in 1884 the Royal medal of that body, the grounds of the award being his mathematical investigations of the secular changes in the relative motions of the earth, moon, and sun, due to internal consumption of energy; and for work on the harmonic analysis of tidal observations. He is a Foreign Member of the American Academy of Arts and Sciences, and of the Reale Accademia dei Lincei, Rome; and an Honorary Member of the University of Padua. The latest recognition of his position in the world of science was that afforded by the conferment of the degree of Doctor of Science, *honoris causa*, at the Encænia, Oxford University, on June 28 last, when he was admitted with the significant salutation, "Docta docti progenies patris."

The British Association:

ITS ORIGIN AND PROGRESS.

Objects of the Association.—To give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate Science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress.

THE British Association for the Advancement of Science is something more than an asset of English science; it may now be truly ranked as an asset of the British Empire. Thus it would seem to have fulfilled the aspirations of those, its founders, "merchants of light," if we may use the term, who cherished a far-seeing vision of ultimate growth and power. We may, however, be sure that none ever dreamed that the peripatetic habits of the Association would extend to so remote a centre as South Africa, now, moreover, an integral part of the King's dominions.

The story of how the Association sprang into existence, and what it has effected, is, or should be, a familiar one to Englishmen, for the history of the British Association during the seventy-four years of its hardy life is in no small degree the history, not only of the progress and range of scientific enquiry in the land of their birth, but a commanding record for an equivalent period of personal achievements. To emphasise this it will suffice to recall such names as Brewster, Sedgwick, Murchison, Owen, Lyell, Faraday, Joule, Darwin, Hooker (happily still among us), Thomson (Lord Kelvin), Stokes, Tyndall, and Huxley, each of whom has given us abiding and profound conceptions in science and the problems of life. Surely every schoolboy in England might find a text of instruction here!

On two previous occasions only has the Association migrated from the Mother Country in order to hold its annual Congress. The first of these was in 1884 when it crossed the Atlantic to meet at Montreal. Lord Rayleigh occupied the presidential chair, and there was an attendance of 1,777 persons. To signalise the event, the British Association instituted in McGill University a prize medal for work in applied science, the obverse of which, it is of interest just now to chronicle, bears the head of James Watt; the reverse has a wreath of maple and rose leaves. With this precedent in mind, South Africa may possibly desire to receive a similar record of the present visit.

In 1897 the Association visited Toronto, having Sir John Evans as President. Here the attendance reached 1,362.

The idea of the British Association as an amalgamation of scientific interests is clearly set forth in a letter addressed by Sir David Brewster in 1831 to Mr. John Phillips, F.G.S., the Secretary of the Philosophical Society of York, and although this has been commented on in all its bearings before now, it will bear recapitulation, more especially at a moment when the Association is breaking fresh ground and is grasping the hands of new friends.

Subjoined is the letter referred to:—

Allerby, by Melrose, February 23rd, 1831.

"Dear Sir,—I have taken the liberty of writing to you on a subject of considerable importance. It is proposed to

Photo by Maull & Fox.

PROF. A. R. FORSYTH, F.R.S.

PROF. ANDREW RUSSELL FORSYTH, Sadlerian Professor of Pure Mathematics in the University of Cambridge, is President of Section A, Mathematical and Physical Science. He is the author of many treatises on subjects of mathematical analysis, and is a Royal Medallist of the Royal Society.

Photo by Maull & Fox.

MR. G. T. BEILBY, F.C.S.

MR. GEORGE THOMAS BEILBY, of Glasgow, President of Section B, Chemistry, is a past president of the Society of Chemical Industry, and an authority on chemistry as applied to the arts of life. He has specially studied the industrial aspects of fuel supplies, and is the compiler of a "Review of the Coal Consumption of the United Kingdom." Among his recent papers are: "The Position of the Cyanide Industry"; "The Intensification of Chemical Action by the Emanations from Gold and Platinum"; and "Phosphorescence caused by the Beta and Gamma Rays of Radium."

Photo by Maull & Fox.]

PROF. H. A. MIERS, F.R.S.

Prof. Henry Alexander Miers, Waynflete Professor of Mineralogy in the University of Oxford, is President of Section C, Geology. Formerly he was an Assistant in the Department of Minerals, British Museum (Natural History). He is the author of many memoirs in mineralogy and crystallography.

Photo by Maull & Fox.]

MR. G. A. BOULENGER, F.R.S.

Mr. George Albert Boulenger, of the Department of Zoology, British Museum (Natural History), is President of Section D, Zoology. He is the author of reference works on Batrachia, Lizards, Chelonians, and Crocodiles, and is an authority on the fishes of Africa.

establish a British Association of Men of Science, similar to that which has existed for eight years in Germany and which is now patronised by the most powerful sovereigns in that part of Europe. The arrangements for the first meeting are in progress, and it is contemplated that it shall be held in York, as the most central city of the three kingdoms. My object in writing to you at present is to beg that you would ascertain if York will furnish the accommodation necessary for so large a meeting, which might perhaps consist of 100 individuals; if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town and in the vicinity would be likely to promote its objects. The principal objects of the Society would be to make the cultivators of science acquainted with each other; to stimulate one another to new exertions; to bring the objects of science before the public eye, and to take measures for advancing its interests and accelerating their progress. The Society would possess no fund, make no collections, hold no property, the expense of each anniversary meeting being defrayed by the members who are present.

"As these few observations will enable you to form a general opinion of the object in view, I shall only add that the time of meeting which is likely to be most convenient would be about the 18th or 25th of July.

"I am, dear Sir,
"Ever most truly yours,
"D. Brewster."

"J. Phillips, Esq."

The Philosophical Society and the civic authorities of York viewed the proposition with every mark of favour, and it was arranged that the inaugural meeting of the Association should be held in the Yorkshire Museum on Tuesday, September 27, 1831, the first President to be Viscount Milton, F.R.S. At this gathering the admirable Statement of Objects, drawn in almost identical terms with those which appear at the head of this notice, was unanimously adopted as the initial propaganda of the Association, and thus it remains to-day.

The second President of the Association was the Rev. William Buckland, D.D., F.R.S., Professor of Geology and Mineralogy in the University of Oxford, and the meeting took place in that city. It has been chronicled by one who was present that Buckland was the life of the whole assembly. Curiously enough no numerical record seems to have been kept of the attendance of members. The third meeting was held under the patronage of the sister University, Cambridge, the Rev. Adam Sedgwick, F.R.S., presiding, after which Edinburgh and Dublin had their turn and the Association was then fairly launched.

It would be tedious to detail the successive doings of the Association year by year, or relate how it has gradually grown in power and usefulness. Annually some suitable provincial town is chosen as the venue, and one visit does not preclude another. But the Association never meets in London. The Presidents have always been selected with a real regard to the position and authority they hold in the branch or branches of science they represent, and it is to this jealous care that much of the repute the Association now enjoys is due. Then, too, their addresses in themselves furnish an epitome of the progress of science. Nor should the loyal services of the General Officers be overlooked; some of them, indeed, will be seen to have directed the helm of affairs for long periods. Incidentally it may be mentioned that His Royal Highness the Prince Consort was President of the meeting held at Aberdeen in 1859.

The work of the British Association is carried on in eleven Sections, which represent, as it were, the cycle

of the sciences. Each has its own president for the time being, and the "Transactions" of these Sections, together with the "Reports on the State of Science" and Presidential addresses constitute the contents of the invaluable series of volumes which have been issued without break since the year 1833, the first date of publication.

As at present constituted the Sections comprise the following divisions:—A, Mathematical and Physical Science; B, Chemistry; C, Geology; D, Zoology; E, Geography; F, Economic Science and Statistics; G, Engineering; H, Anthropology; I, Physiology; K, Botany; L, Educational Science. The employment of alphabetical letters to distinguish the Sections was introduced in 1835.

The discussions on scientific questions which annually take place in the Sectional Committees were regarded from the first as calculated to foster and strengthen the spirit in which the Association was conceived, as well as exemplifying its principles. But the enormous extension in the boundaries of science which the past fifty years has witnessed has naturally brought in its wake an enlarged platform for the stream of criticism and comment. This development has, indeed, suggested to some of the veteran habitués of the meetings that there is now, perhaps, an over-expression of opinion, and they recall with lingering regret the notable assemblages of a brilliant, if small, band of scientific expositors, whose personality was the focus of the gatherings; their flights into the whirlpools and rapids of argument or conjecture, a keen and satisfying experience. But without "talk" the modern Congress would die of inanition; it is, in short, a safety-valve that had best be left untouched.

Since 1867 an interesting and popular feature of the meetings has been the delivery of a lecture on some particular scientific subject, designed especially for an audience of working-men. The first of the series was given by John Tyndall, on "Matter and Force," and at last year's Cambridge gathering there was a discourse on "The Form of Mountains."

In 1884 a "Corresponding Societies Committee" was instituted with the view of encouraging the affiliation of local Scientific Societies in order that they might be formally in correspondence with the Association, and thus assist in promoting its objects. At present 72 local bodies constitute Corresponding Societies, but it is hoped that this relatively small number will steadily increase.

No outline of progress should, however, omit to mention the money grants which the Association has bestowed from its necessarily limited funds in furtherance of scientific purposes. The grand total of such sums allotted since the year 1834 amounts to no less than £68,300.

Our survey, brief though it is, will, perhaps, serve to indicate the plan and general scope of the organisation, as well as the fruitfulness of its career.

It stands to-day, as in the past, moved by no advertisements or trumpeting fanfares, or idea of self-aggrandisement, essentially a silent force working with definite aims and understanding for the advancement of the several branches of scientific thought and knowledge. Actuated thus, the Association transplants its standard to South Africa, a step bold and far-seeing enough to command a common approval, as also it enlists our brightest hopes for a successful and prosperous gathering.

Photo by Maull & Fox.]

SIR W. J. L. WHARTON, K.C.B., F.R.S.

REAR-ADMIRAL SIR JAMES LLOYD WHARTON, till lately Hydrographer of the Navy, is President of Section E, Geography. He has had charge of Surveys in various parts of the world. Author of a work on "Hydrographical Surveying." In 1871 he took part in observations on the Transit of Venus.

Photo by Maull & Fox.]

REV. W. CUNNINGHAM, D.D.

THE REV. DR. CUNNINGHAM is President of Section F, Economic Science and Statistics. Fellow of Trinity College, and Lady Margaret Preacher. Sometime Lecturer in Economic History, Harvard University. Author of "Growth of English Industry and Commerce in Modern Times," 1901 (3rd ed.); "The Use and Abuse of Money"; "Gospel of Work"; "Ancient Times" "The Path towards Knowledge."

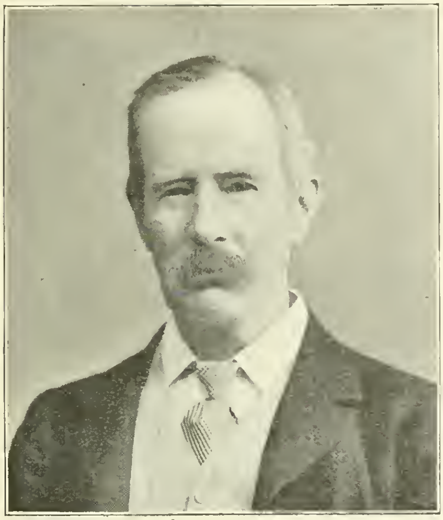


Photo by Maull & Fox.]

SIR C. SCOTT-MONCRIEFF, G.C.S.I.

Colonel Sir C. Scott-Moncrieff, late Bengal Engineers (medal Indian Mutiny), is President of Section G, Engineering. He has been respectively Under-Secretary, Public Works Office, Egypt, and Under-Secretary for Scotland. In the former capacity, he carried out important work in connection with Nile barrage. Author of "Irrigation in Southern Europe."

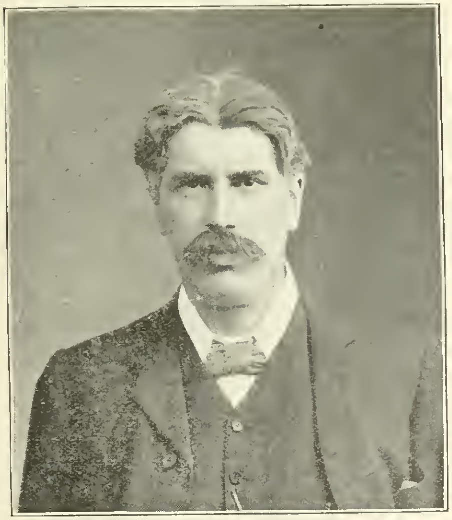


Photo by Maull & Fox.]

DR. A. C. HADDON F.R.S.

Dr. Alfred Cort Haddon, University Lecturer in Ethnology in the University of Cambridge, formerly Professor of Zoology in the Royal College of Science, Dublin, is President of Section H, Anthropology. In 1888, he went to Torres Strait to investigate the structure of the coral reefs, and the fauna, and also studied the ethnography of the Islanders.

Programme of the Meeting.

On Saturday, July 22, the *Durham Castle* and *Kildonan Castle* sail for South Africa, carrying, respectively, a complement of 108 and 45 members of the Association. On Saturday, July 29, the *Saxon* sails with 139 members, who constitute the Official party, and are the guests of the South African Colonies. With earlier departures, the total number proceeding to the meeting will fall little short of 400.

CAPE TOWN.—The *Saxon* arrives at Cape Town (early morning) on Tuesday, August 15, and the work of the Association commences forthwith. A meeting of the Council will take place at noon, and the 11 Sectional Committees and the General Committee will also foregather.

The President's Address to the Association will be delivered (in part) at the inaugural meeting to be held in the evening.

In this, Professor Darwin proposes to discuss the general principles involved in theories of evolution, with special reference to the world of inanimate matter. He will illustrate the subject by means of various theories of the intimate constitution of matter and of cosmical evolution.

August 16.—Presidential Addresses to Section A, Mathematics and Physics; Section D, Zoology; Section E, Geography; Section F, Economic Science and Statistics; Section H, Anthropology; and Section L, Educational Science.

In the afternoon a garden party will be given by His Excellency the Governor (Sir Walter F. Hely-Hutchinson); in the evening there will be a reception by the Mayor of Cape Town.

August 17.—Sectional Meetings.

In the evening Prof. E. B. Poulton, F.R.S., delivers a lecture on "W. J. Burchell's Discoveries in South Africa."

August 18. Sectional Meetings.

In the evening Mr. C. V. Boys, F.R.S., delivers a lecture on "Some Surface Actions of Fluids." Following this a conversazione will be given by the combined scientific societies of Cape Town, at the South African Museum.

In the afternoon, Sir David Gill, K.C.B., F.R.S., will give a reception at the Royal Observatory.

The "Saxon" leaves for Durban (evening).

August 19.—Whole day excursions to, among other places of interest: Table Mountain; De Beers Explosive Works; Hout Bay; Admiralty Works, Simon's Town; Marine Station, St. James's.

The "Durham Castle" leaves for Durban direct, arriving in the forenoon of Tuesday, August 22.

DURBAN.—*August 22.*—A lecture will be delivered in the Town Hall in the evening by Mr. Douglas Freshfield, F.R.G.S., on "Mountains: the Highest Himalaya."

In the afternoon a garden party at Sir Benjamin Greenacre's.

August 23.—Visit to Botanic Gardens; trip (full day) to Umkomaas; circular trip round the Bay; inspection of Girls' Model Primary School; Mount Edgecombe (Sugar Estate); Parade of Cadets.

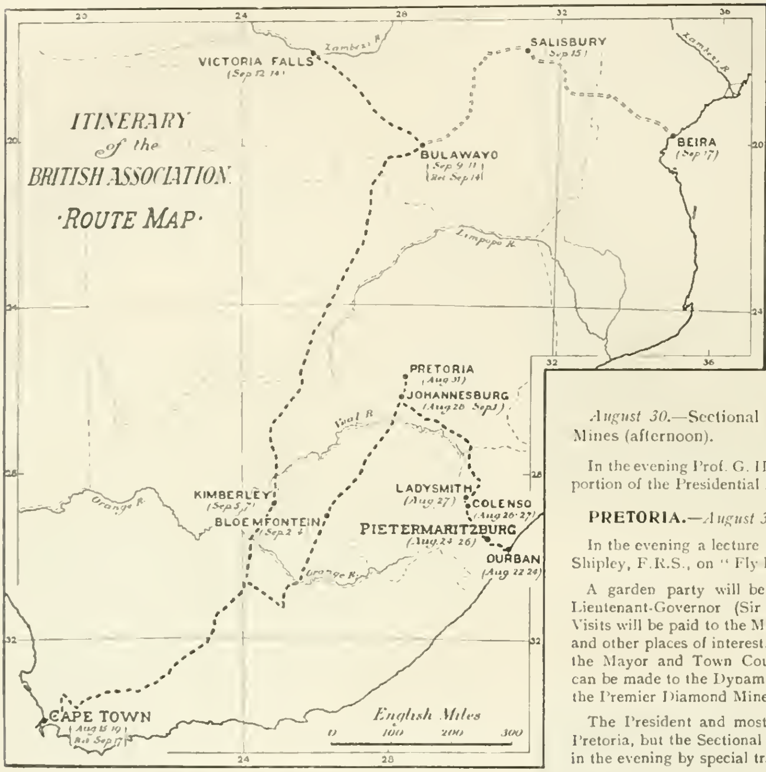


TABLE OF DISTANCES

	Miles.
Southampton to Cape Town	5,978
Cape Town to Johannesburg	1,013
Cape Town to Bloemfontein	750
Cape Town to Kimberley	647
Cape Town to Bulawayo	1,362
Bulawayo to Victoria Falls	275

PIETERMARITZBURG. *August 24.* Leave Durban for Pietermaritzburg, by special trains (morning). In the evening, Colonel David Bruce, C.B., F.R.S., will deliver a lecture on "Sleeping Sickness."

In the afternoon, a garden party

August 25.—Visits to the Museum, Educational Institutions, and Public Buildings generally.

Excursion to Native Location, Henley, with Kafir dance; Government Experimental Farm, Cedara, Government Laboratory, Allerton; Town Bush Valley Nurseries.

August 26.—Leave Pietermaritzburg by special trains for a visit to Colenso; sleep in the special trains; leave for Ladysmith *August 27* (Sunday) and visit the town; depart same day for Johannesburg.

JOHANNESBURG.—*August 28.*—In the evening a lecture will be delivered by Prof. W. E. Ayrton, F.R.S., on "Distribution of Power."

August 29.—Sectional Meetings. Presidential Addresses to Section B, Chemistry; Section C, Geology; Section G, Engineering; Section I, Physiology; and Section K, Botany.—A Report by Mr. G. W. Lamplugh, F.R.S., on the "Geology of the Victoria Falls," will take the form of an afternoon address to Section C.

In the afternoon a garden party will be given by His Excellency the High Commissioner for South Africa (the Earl of Selborne, G.C.M.G.); in the evening, a reception by the Mayor and Town Council of Johannesburg.

August 30.—Sectional Meetings (morning); visit to Mines (afternoon).

In the evening Prof. G. H. Darwin will deliver the second portion of the Presidential Address in St. Mary's Hall.

PRETORIA.—*August 31.*—Visit to Pretoria.

In the evening a lecture will be delivered by Mr. A. E. Shipley, F.R.S., on "Fly borne Diseases, Malaria, &c."

A garden party will be given by His Excellency the Lieutenant-Governor (Sir Arthur Lawley, K.C.M.G.). Visits will be paid to the Museum and Zoological Gardens, and other places of interest. A luncheon will be given by the Mayor and Town Council of Pretoria. Excursions can be made to the Dynamite Factory, Modderfontein, and the Premier Diamond Mine.

The President and most of the members will sleep at Pretoria, but the Sectional officers return to Johannesburg in the evening by special train.

JOHANNESBURG.—*August 31.*—In the evening a lecture will be delivered by Prof. J. O. Arnold on "Steel as an Igneous Rock."

September 1.—Sectional Meetings (morning); General Committee (afternoon).

In the afternoon there will be a Kafir dance at the Wanderers' Club. During the Johannesburg visit various excursions will be made, and visits of inspection paid to Public Buildings and to the Government Experimental Farm, Potchefstroom. There will also be a cross-country trip for a limited number to Mafeking.

BLOEMFONTEIN.—*September 2.*—A lecture will be delivered in the evening by Mr. A. R. Hinks, on "The Milky Way and the Clouds of Magellan."

A public welcome will be extended to the Association by the Mayor and Town Council of Bloemfontein, and there will be a reception at Government House.

September 3 (Sunday).—Special train to Modderpoort, stopping at Sannah's Post; lunch on board the train, provided by the hospitality of the town. A trek to Kimberley will be arranged for a limited number, touching Driefontein and Paardeberg, and camping in General Cronje's old laager.

September 4.—Leave Bloemfontein by special trains for Kimberley.

KIMBERLEY.—*September 5.*—In the evening a lecture will be delivered by Sir William Crookes, F.R.S., on "Diamonds."

Underground visits to Mines (in parties) will be made. There will be a garden party at the Public Gardens

Photo by Maull & Fox.]

COL. BRUCE, C.B., F.R.S.

COL. BRUCE, R.A.M.C., President of Section I, Physiology, now resident in London, was formerly quartered at Pietermaritzburg. An authority in various branches of Pathological enquiry, he discovered (1887) the micro-organism of Malta Fever (*Micro-coccus Melitensis*). In Zululand, under official auspices, he studied the devastating Tsetse Fly disease, or Nagana. In Uganda, he recently investigated with striking success the causation of the dreaded malady Sleeping Sickness, and denoted the actual carrier of the infective organism to be a species of Tsetse Fly.

MR. H. W. T. WAGER, F.R.S.

MR. HAROLD W. T. WAGER, H.M. Inspector of Schools (Secondary Branch), President of Section K, Botany, was formerly Lecturer on Botany in Yorkshire College, Leeds. He is the author of numerous botanical memoirs, among these "The Sexuality of the Fungi"; "On the Phosphorus containing-Elements in Yeast."

Photo by Maull & Fox.]

SIR R. C. JEBB, M.P., O.M.

SIR RICHARD CLAVERHOUSE JEBB, Regius Professor of Greek in the University of Cambridge, is President of Section L, Educational Science. A distinguished member of the British Academy, he was recently the recipient of the Order of Merit. He represents Cambridge University in Parliament.

September 6.—In the evening a lecture will be delivered by Prof. J. Bonsall Porter, of Montreal, on "The Bearing of Engineering on Mining."

In the morning the whole body of visitors will entrain at Kimberley for Beaconsfield, thence to De Beers Sidings, and will proceed by rail to Du Toit's Pan and Wesselton Mines. Trips will be made to Kenilworth, Pulsator, and Alexandersfontein.

September 7-8.—Leave Kimberley *en route* for Bulawayo (Official party).

BULAWAYO.—*September 9.*—In the evening a lecture will be delivered by Mr. Randall MacIver on the "Zimbabwe."

In the course of the morning and afternoon the Public Buildings, Memorials, and Museum will be inspected; in the evening a conversazione will take place in the Drill Hall.

September 10 (Sunday).—Leave for Matopos by train; travel by coach through the Matopos to the World's View. Inspect Rhodes Park, the site of the grave of Mr. Cecil Rhodes, Shangani Memorial, and the Khami Ruins, and return to Bulawayo.

September 11.—Official party leaves for the Victoria Falls.

September 12.—Arrive at Victoria Falls; visit the Palm Grove, Rain Forest, Zambezi Bridge, &c.

September 13.—Leave Victoria Falls (morning) for Bulawayo.

September 14.—Official party arrives at Bulawayo (early morning), Garden party in South Park (afternoon). Official party leaves for Cape Town (evening), arriving Sunday, September 17 (afternoon).

September 20.—The Official party, homeward bound, leaves for England, arriving at Southampton on Saturday, October 7.

Members who are returning to England by the Beira route leave the Victoria Falls, September 14, and embark on the *Durham Castle* on Sunday, September 17. The ports of call are: Mozambique, Zanzibar, Mombasi (Kilindini), Port Said, Marseilles, and Southampton, the last-named being reached on October 20.

THE BRITISH ASSOCIATION, 1905.

President.

PROFESSOR G. H. DARWIN, M.A., LL.D., Ph.D., F.R.S.

Vice-Presidents.

HIS EXCELLENCY THE RIGHT HON. THE EARL OF SELBORNE, G.C.M.G., High Commissioner for South Africa.
THE RIGHT HON. LORD MILNER, G.C.B., G.C.M.G., late High Commissioner for South Africa.
THE HON. SIR WALTER F. HELY-HUTCHINSON, G.C.M.G., Governor of Cape Colony.
COLONEL SIR HENRY E. McCALLUM, G.C.M.G., R.E., Governor of Natal.
CAPTAIN THE HON. SIR ARTHUR LAWLEY, K.C.M.G., Lieutenant-Governor, Transvaal.
MAJOR SIR H. J. GOOLD-ADAMS, K.C.M.G., Lieutenant-Governor, Orange River Colony.
SIR W. H. MILTON, K.C.M.G., Administrator of Southern Rhodesia.
SIR DAVID GILL, K.C.B., LL.D., F.R.S., H.M. Astronomer, Cape Colony.
SIR CHARLES H. T. METCALFE, Bart., M.A.
THEODORE REUNERT, M.Inst.C.E.
THE MAYOR OF CAPE TOWN.
THE MAYOR OF JOHANNESBURG.
THE PRESIDENT, PHILOSOPHICAL SOCIETY OF SOUTH AFRICA.
THE MAYOR OF DURBAN. THE MAYOR OF MARITZBURG.
THE MAYOR OF BLOEMFONTEIN. THE MAYOR OF PRETORIA.
THE MAYOR OF KIMBERLEY. THE MAYOR OF BULAWAYO.

General Treasurer.

PROFESSOR JOHN PERRY, D.Sc., F.R.S.

General Secretaries.

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PROFESSOR W. A. HERDMAN, D.Sc., F.R.S.

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SIR DAVID GILL, K.C.B., F.R.S., *Chairman.*
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A. SILVA WHITE, *Assistant Secretary.*
H. C. STEWARDSON, *Chief Clerk* and *Assistant Treasurer.*

The Races of South Africa.

THREE main races may be distinguished in the south of the African continent: the Bushmen, the Hottentots, and the Bantu-speaking peoples. None of these possess any written records, and the only materials for their history consist in native traditions and folk-lore, and the reports of travellers of the past hundred years or so. From these sources of information an attempt has been made to trace the origins and early relationships of the indigenous tribes, but much work remains to be done before any definite ethnological grouping can be verified.

Bushmen.—When the early travellers landed at the Cape, the first peoples with whom they came in contact were the San and Khoikhoi, better known respectively as the Bushmen and the Hottentots. The former were the aboriginal inhabitants of the south of the continent, and there is evidence to show that before the era of the Bantu migrations from the north-east, they occupied the land south of the equatorial lakes.

The Bushmen were a hunting people, living on the abundant game, owning no lords, and possessing no political organisation. But at the very beginnings of South African history we see their doom foreshadowed, for this aboriginal hunting folk could make no stand against the steady migration of the Bantu-speaking tribes pouring down from the north-east, and in the 17th century they were being gradually driven out of the more fertile lands into the south and west. The settlers proved an even more dangerous enemy on the south, for by the Europeans these aboriginal owners of the land were treated, not as men, but as wild animals, to be exterminated. The extermination would have proceeded more rapidly had not the Bushmen been possessed of one admirable means of defence. Their only weapons were bows and arrows; the bows usually very poor and the arrows often merely made of reeds, but the piece of bone, flint, or iron forming the tip was dipped in deadly poison, which rendered a slight wound mortal; and the colonists learnt to mingle fear with their contempt. Sentries were practically useless against these wary attackers, and one Bushman could keep a whole European settlement in a state of constant alarm. Owing to his diminutive size and his extraordinary ability for taking cover, he could make himself almost invisible, and the skill and cunning of the born hunter were preternaturally sharpened when he himself became the quarry. Much of the disafforesting of South Africa was due to the fear of the Bushmen, for the colonists cleared all the bush near their dwellings to guard against stealthy attacks.

Between the dense masses of Bantu peoples sweeping down from the north-east, and the ever-encroaching colonists on the south, the Bushmen were forced to retreat, and they sought refuge in the fastnesses of the mountains and in the deserts, where they are still to be met with, still living in the primitive method, by hunting, still using the same rude weapons, the bow and arrow; still in the stone age of culture from which our ancestors emerged some few thousands of years ago, and still making fire by friction, like prehistoric man and savages all over the world.

In physical characteristics they differ considerably from their Bantu neighbours. The skin colour is naturally a fawn yellow, and even when obscured by layers of grease and dirt, it is distinctly lighter than the prevailing tint in the Dark Continent. The black hair has earned by its method of growth the name of "pepper-corns," for though it is distributed normally and evenly over the surface of the head, the little short black tufts cling together in tight spirals, leaving bare spaces between, and suggesting a sprinkling of pepper-corns over the scalp. The average stature is 1.529m. (5 ft. 0¼ in.). The head is low and moderately narrow, the face straight, without projecting jaws, the nose extremely low and broad.

Hottentots.—While the Bushmen were nomadic hunters, the Hottentots were nomadic herdsmen, and they are generally assumed to represent an early blend in another part of the continent of Bushmen and Bantu stocks. In skin colour, in the nature of the hair, in certain physical characteristics and in speech they show considerable affinities with the Bushmen, but they are distinguished by a taller stature, 1.639m. (5 ft. 4½ in.), a narrower head, and pronounced projection of the jaws.

They formerly extended from Namaqualand on the west to beyond the Limpopo, and traces of their occupation are recognised in the heaps of stones or cairns which mark the graves of their warriors. The true Hottentots are now mainly confined to Namaqualand on the west, but tribal groups of the Korannas (Koraqua) of the middle and upper Orange and Vaal rivers, and Hottentot-Bantu or Hottentot-Boer half-breeds, such as the Griquas of Griqualand E. and the Gonaquas, are relics of this once powerful race. Their extinction is due to many causes. Bantu invasions on the north-east, and the encroachment of the colonists on the south, deprived them of the more fertile lands, which want of organisation prevented them from protecting. Like the Dinka of the Upper Nile, and the Todas of the Nilghiris, they have a passionate devotion for their cattle, and it was on account of their herds that they first came in conflict with the Dutch settlers, whose farms threatened their pasturelands. As these were

gradually occupied by the stronger races, the Hottentots could no longer support their herds, their only means of existence, and many were reduced to slavery on the farms of the invaders, where their cleverness in handling cattle made them valuable as drivers of bullock waggons. Their light attachment to the soil, due to their inherent love of wandering, made their displacement the less difficult, and the national vice of dacha-smoking to excess, together with the vice of spirit drinking, acquired from the settler, accelerated their degradation.

Koranna.—The Koranna occupied the Middle Orange in the 17th century, but they were always a restless people, whom nothing would bind to the soil. One section of them went up the Vaal and formed an independent kingdom round the town of Mamusa on the Harts river, where they still keep up many of the national customs and speak a corrupt form of the Hottentot language; but owing to their long intercourse with the Kafir tribes, they have developed the physical characters of the latter, and cannot be regarded as pure Hottentots.

Griqua.—The Griqua are Boer-Hottentot half-breeds, whose original home was to the north of the river Olifant. They were forced to retreat before the colonists and founded a republic at Rietfontein. Discords soon led to disruption. One section, under Adam Kok, founded Philippolis and later on Kokstadt in Griqualand East, and another section, under Andries Waterboer, founded Griqua Town in Griqualand West.

Bantu.—In Natal we find ourselves in the midst of a typical Bantu people, the Zulu-Xosa, or Zulu-Kafirs, from whose language the group-name Bantu (people) has been chosen as a general term to include all the African races of Bantu speech. This artificial grouping conceals a heterogeneous mass, containing at least six distinct elements, true Negro, Negrillo, Bushman, Hottentot, Hamite, and Semite, which are blended together in different proportions, producing a wide diversity in physical type.

The chief characteristics of the main Bantu groups are a fairly tall stature, a skin colour of varying shades of red-brown, a high and narrow head, a broad nose, and thick but not everted lips.

It seems probable that the Bantu type is mainly due to a blending of the true Negro, of the type found to-day in greatest purity in West Africa and the Sudan, with a Hamitic stock, and that the centre of the dispersion was somewhere in the neighbourhood of British East Africa. From their dual ancestry the Bantu inherited the aptitude for agriculture, and for cattle-rearing, and, provided thus with an ample supply of food, living in a magnificently fertile area, possessing also a political organisation, which developed into tribal grouping, they flourished, and increased and multiplied to such an extent that now their teeming millions swarm over almost the whole of South Africa.

In their earlier wanderings they must have mixed to a considerable extent with the aboriginal inhabitants, and we find distinctly Hottentot features among the Bechuana, who are regarded on this and other grounds as being among the earliest immigrants. The later waves preserved a purer type, such as the Zulu-Xosa, who are comparatively recent arrivals in their present territory, though a long period of contact with the aborigines is shown by the adoption of three clicks into the language.

Xosa.—At one time the Xosa spread far to the south, and the first conflict with the whites took place in the Swellendam district in the middle of the 18th century. Later on the boundary was fixed at the Great Fish river, but the rapidly increasing people had spread by 1800 as far as Mossel Bay. Then force was brought to bear on them, and troops were called out, but the general retreat did not take place until 1835. External restrictions produced internal shiftings and d' turbances and general disorganisation, leading to a loss of independence for all the clans.

Zulus.—The history of the Zulus, the northern branch of the Zulu-Xosa, is well known since the time when they sprang into notoriety under the famous Chaka, the terror of whose name was carried for hundreds of miles in every direction by tribes which he had put to flight. Streams of disorganised people fled before him, and some of these, encountering weaker tribes in their flight, attacked them and took possession of their lands: thus the disorganisation spread. The Fecane, or Fingu, Xezibe, Baca, and Amahlubi fled to the south, and the Fecane, after being slaves to the conquerors, were freed in 1835, and formed the Fingu location near Port Elizabeth.

Matabele.—The Matabele, "the men who disappear," so called from their immense bucklers, having fled across the Drakensberg, gathered together under Umsilikatsi and poured in a vast army across Bechuanaland, conquering the sedentary tribes, and augmenting their numbers by captives and fugitives. They were defeated and almost annihilated by the Boers, but this catastrophe was only a brief check in their victorious career, which culminated in the defeat of the Mashona and the occupation of Mashonaland, Rhodesia.

Mashona and *Makalaka.*—The Mashona and Makalaka were probably among the earlier waves of Bantu migration. Tradition ascribes to the Makalaka a powerful kingdom, which lasted for 300 years, between the Limpopo and the Zambezi, and the Mashona lived to the north of them as far as the Umfuli river. They were powerless before the warlike Matabele, and were either reduced to subjection or sought refuge in flight.

Barotse and *Makololo.*—Another powerful kingdom was that of the Barotse, on the middle Zambezi. This was overthrown by the Makololo, under Sebituane, in 1835, but on the death of Sekeletu, the successor of Sebituane, the Barotse revolted, drove out the Makololo, and re-established their empire on a surer footing.

Thus the history of the Bantu peoples is one of continuous movement, of perpetual shiftings, of states formed by the grouping of many tribes under one forceful leader, and the disruption of these states, either by natural disintegration when the central power weakens, or before the attack of some greater or stronger force. The grouping is political rather than racial, and hence it tends to produce a blending rather than a differentiation of type.

The ethnology of a country is always influenced by the environment, and this is notably the case in South Africa. Here is an immense stretch of country, containing few barriers to limit expansion in any direction or to provide security against attack. Hence the racial history has shown streams of people perpetually moving in all directions, producing an infinite fusion of types, a uniformity in diversity, which makes South African ethnology a subject of unusual complexity, needing a great deal of patient unravelling before the affinities of even the main races can be clearly discovered.

The Diamond Mines of South Africa.

ABOUT forty-eight years ago a child picked up a diamond in the gravels of the Orange River. Experts in Europe were not very ready to believe the news, but others were found, and in 1870 the gem was discovered in the so-called "dry ground"—large patches of a peculiar clayey material well away from any stream course. This was at a spot which is now the noted Dutoits Pan Mine, near Kimberley. During the next year three other diamantiferous patches were detected in this neighbourhood; one, the present Bultfontein Mine, within a short distance to the south; another, the De Beers, about two miles away to the north-west, and the third, the Kimberley, about a mile west of it. They formed low hills or kopjes, rising from a comparatively level basin; the tops of the Kimberley and its neighbour being about 4,000 feet above sea-level, and the others a few hundred feet lower. The country rock is a dark shale, with occasional beds of hard sandstone, belonging to the Karoo series of geologists, which is either a little older than, or contemporary with, the European Trias, and is very different from the diamantiferous material, which was afterwards found to fill large vertical pipes or funnels, descending to an unknown depth. These were nearly oval in form, the area of the largest, Dutoits Pan, being about 41 acres; that of the smallest, the Kimberley, about nine acres. Since then several other diamantiferous patches have been discovered, to which we shall presently refer.

The nature of the material and the origin of the gem have long been geological problems, but the former of them has at length been solved, and the latter is much better understood. The difficulty partly arose from the state of the material. The yellow ground, to use the miners' name for that first dug up, was a rotten clayey stuff in which sundry minerals and rock fragments were scattered. This, they found, passed gradually down—perhaps a hundred feet from the surface—into a dark bluish-green material, which they called "blue ground." Though more coherent than the other, it also was at first ill-suited for microscopic examination, by which, however, the minerals scattered through it, sometimes as fragments, could be determined. The more notable, besides the diamonds, were garnets of one or two kinds, iron oxide, generally titaniferous, a brown mica, named vaalite by Professor Story-Maskelyne, a chrome-augite, enstatite, and olivine, more or less converted into serpentine. Fragments of rock, sedimentary and crystalline, were also present; the former often seeming slightly altered. About one-third of the matrix, or blue ground itself, consisted of very minute fragments of these constituents; about half was serpentine, and the remainder a carbonate of lime, sometimes magnesian.

It was impossible to determine the true nature of this rock, or the origin of the diamond, until the blue ground was hard enough to be cut into slices sufficiently thin for a satisfactory examination with the microscope, and this was not reached until the mines were carried down to some hundreds of feet from the surface. The exact depth cannot be precisely stated, or that of the passage from the "yellow" to the "blue ground," but it was not till about a dozen years ago that really good specimens of the latter reached this country. The Kimberley mines had by that time been carried to a depth of over a thousand feet, and the material brought up was about as hard as an ordinary limestone.* These workings also afforded sections of the rocks pierced by these great pipes or shafts. First they found the dark shales already mentioned, sometimes covered, sometimes cut, by masses of an igneous rock allied to basalt. These occupy the first few hundred feet. Beneath them comes a thick mass of similar rock, an old lava flow, often called melaphyre, resting (in the Kimberley district) on a quartzite or very hard sandstone, which continues, thickly interbanded with the dark shales, till, at a depth of more than five hundred yards from the surface, a floor of very ancient crystalline rock is reached. The rock fragments in the blue ground are similar to these, whether sedimentary or igneous; the shales being sometimes quite unaltered, but sometimes with a "baked" aspect, especially in their outer part. The rock, then, is a breccia, and often bears a rough resemblance to that which fills the volcanic necks on the Fifeshire coast. That the pipes had been driven in some way or other through the surrounding rock was indisputable, but it was for long uncertain whether the material in them was a true breccia, like that just mentioned, or some peculiar kind of igneous rock. The latter view was at first more general, and was not incompatible with the presence of rock fragments. The late Professor Carvill Lewis maintained the material (which he named Kimberlite) to be a peculiar kind of peridotite—a rock composed mainly of olivine, but with a glassy matrix—in which the diamonds and other minerals had formed. But farther examination showed the latter to be in many cases indubitably broken, and the rock is now generally admitted to be a true breccia. It has, however, a volcanic or, perhaps, we should say, an explosive origin since we find no signs of ordinary scoria. After the pipes had been filled, steam or hot water probably continued to be discharged for some time, converting the ferromagnesian minerals into serpentine, producing carbonates, forming a peculiar coating on some of the garnets, and more or less affecting the rock fragments.

This, however, did not settle the question whether the diamonds had originated in the pipes or elsewhere, like the other larger minerals. Professor Carvill Lewis, taking the Kimberlite to be an igneous rock, held the former view. So did some of those who maintained it to be a breccia, for they thought the diamond had been produced by the action of very hot water on the carbonaceous material of the dark Karoo shales. But this hypothesis is beset with insuperable difficulties. The crystals of diamond are not unfrequently broken like the garnets or augites, and when perfect are often in a state of strain. Either would be inexplicable had they been formed in such a material as the breccia. Besides this, small diamonds have been found at the De Beers and the Newlands mine (some forty miles north-west of Kimberley), more or less included in garnets, and in 1897 they were detected in two boulder-like pieces of rock which had been brought to England from the latter mine. One of these, when it was broken, displayed in the largest fragment no fewer than ten diamonds, the biggest—an octahedron—measuring about three-twentieths of an inch from point to point.†

* See Papers in the *Geological Magazine* for 1895, p. 492. Illustrations of the material itself and of its microscopic structure are given in Carvill Lewis' "The Genesis of the Diamond," 1897.

† This fragment was presented by the Directors of the Company to the British Museum. For an account of it, see *Proc. Roy. Soc.*, Vol. LXV., p. 223.

The rock is an eclogite, consisting mainly of red garnets ranging in size from a hemp seed to a pea, and green (chromiferous) augite. This eclogite is now regarded as an igneous rock, and one of those which have crystallized at a considerable depth from the surface. Diamonds, with other forms of crystallized carbon, have been found (though rarely) in meteorites, not only in those of native iron, as at the Cañon Diablo, but in one composed of this metal crystallized with olivine and augite, which fell in 1885 at Nova Urei in Russia. Professor Moissan has made small diamonds by fusing carbon in iron, and cooling the mass so as to cause great pressure at the interior—an experiment which has been repeated by Sir W. Crookes. We must, therefore, conclude that the South African diamonds originated in deep-seated igneous rocks. They have, as yet, been detected only in eclogites, but we may anticipate their occurrence in other crystalline rocks with a lower percentage of silica, and especially in peridotites. These deep-seated masses must have been stripped of their covering and laid bare before the Triassic period began; fragments were detached and rolled into pebbles, forming the conglomerate at the base of the Karoo series, which was duly covered up by the sandstones and shales towards the end of this period. Movements of the earth's crust in Southern Africa caused discharges of lava, in the form of flows and dykes. Then great explosions drilled huge holes through all these, and hurled the shales, quartzite, conglomerate, and the shattered crystalline floor into the air. This mixed stuff, minerals and rock, as it fell back, finally filled the pipes, which, however, continued to be vents for gas, steam, and, perhaps, hot water.

Such is the story of the diamond. There are several other pipes more or less productive, most of which are scattered on a narrow belt about 125 miles in length, which runs, roughly, in a N.N.W. to S.S.E. direction from Newlands on the Hart river in West Griqualand to Faure Smith in the Orange State, parallel, as Dr. Molengraff has pointed out, with the line of the Drakensberg Range. But the group, including the Premier Mine, now famous for the discovery of the Cullinan diamond, must belong to quite another zone of disturbance, for it is about seven leagues east of Pretoria (north of Van der Merve Station). Here the pipes are driven through quartzite and an igneous rock called felsite, so the Karoo shale cannot have helped to make these diamonds.

We must pass over the story of the working of the mines, for it is a long and complicated one, contenting ourselves with stating that, according to De Launay, richer mines produce on an average about 15 grains weight of diamonds to five cubic yards of rock, and that, by 1896, South Africa had produced more than double the quantity of Brazil and India together. A decade earlier its mines in a single year yielded nearly 3,160,000 carats of diamonds.

View of the Cullinan Diamond, showing one of the great cleavage planes. It is resting on another cleavage plane. Approximately natural size.

From a Photograph by Sir William Crookes, F.R.S.

These stones frequently show a very faint resin-yellow tint, but many are perfectly colourless and free from any flaw. The first exceptionally fine one, the Star of South Africa, weighing $83\frac{1}{2}$ carats, was found in 1869. Three years later diggings on the Vaal River produced the Stewart, $228\frac{3}{4}$ carats. The De Beers Mine came to the front in 1880 with a diamond weighing $428\frac{1}{2}$ carats, which was beaten four years afterwards by one (locality uncertain) weighing $457\frac{1}{2}$ carats.—"On June 30, 1893, the Jagersfontein Mine (the best in the Orange River State) broke the world's record by disclosing a diamond weighing $971\frac{3}{4}$ carats. It was rather irregular in shape—something like a longish potato—measuring about 3 inches by a little less than $1\frac{1}{2}$ inches." But on January 25 in the present year that was left far behind by the Cullinan diamond, which was found about 18 feet below the surface at the Premier Mine, Transvaal, and of which we give a photograph. It is a stone of excellent water, weighing about $3{,}024\frac{3}{4}$ carats.* Yet this monster is itself only a fragment, for four of its bounding faces are cleavage planes, and experts think that the stone, when perfect, may have been quite twice as heavy.

* A carat is $3\frac{1}{5}$ grains, Troy.

South African Natural History.

Antelopes.—In spite of what we sometimes hear our sporting friends chronicle as to their having shot this or that kind of small "deer" in South Africa, meaning, in reality, some kind of antelope, the fauna of the country is notable on account of the absence of representatives of the deer family (*Cervidæ*), as also of representatives of sheep and goats, and of true wild cattle. The place of the last named is taken by the great and ugly Cape buffalo (*Bos caffer*), an animal entirely different, however, from the water-buffalo with which we are familiar in Italy and other parts of Southern Europe; and the deer of Europe and Asia are replaced in South Africa by a vast assemblage of species of antelopes, many of which are peculiar to the country, although a large percentage belong to genera ranging over the greater part of Africa.

One very characteristic animal is the Cape hartebeest (*Bubalis cama*), a melancholy-looking antelope of the size of a donkey, with a prodigiously long face, twisted lyrate horns, and a foxy-red coat relieved with bluish black. Despite its advantage of being one of the fleetest of South African antelopes, it is now almost killed off in Cape Colony, the Orange River Colony, and the Transvaal, though a few survive in the old Bushman country of Cape Colony and in the North-West Transvaal. In the Kalahari desert big troops still remain. The lovely blesbok and boftebok (*B. albifrons* and *B. pygargus*) were also characteristic South African antelopes, and at one time occurred in tens of thousands; but while the former still exists on several Boer farms in the Orange River Colony and the Transvaal, the latter is represented only by a herd on some flats forming part of the estate of Mr. Vander-Byl near Swellendam, in the south of Cape Colony. Yet another antelope abundant formerly, when it associated with quaggas and ostriches, was the white-tailed gnu, or black wildebeest (*Connochoetes gnu*), which never ranged north of the Vaal River. Before the Boer war it was recorded only on a few farms in the Orange River Colony, and little has been heard since with regard to the species. North of the Orange River its place is taken by the brindled gnu, or blue wildebeest (*C. taurinus*), a species still locally not uncommon. In connection with the hartebeest and gnus may be mentioned the bastard hartebeest, or sassabi (*Damaliscus lunatus*), which surpasses the first in speed, and is an exclusively South African species, now relatively scarce.

Of the smaller South African antelopes, the duiker (*Cephalophus grimmi*), the oribi (*Oribia scoparia*), the grysbok (*Rhaphiceros melanotis*), and the steinbok (*R. campestris*), still survive locally in fair numbers. The beautiful little klipspringer (*Oreotragus saltator*), the so-called South African chamois, is worthy of notice as a mountain species. In the waterbuck (*Cobus ellipsiprymnus*), easily recognised by the long and beautifully-ringed horns of the bucks, and the white ellipse on the buttocks, we have a magnificent species now most common in the unhealthy swamps between the Chobi and Zambezi. The vaal roebuck (*Pelea capreolus*) is a much smaller grey animal, with short upright horns to the bucks, inhabiting open, hilly districts south of the Zambezi. Nearly allied is the fox-red reedbuck (*Cervicapra arundinum*), a now scarce species inhabiting river banks. The lovely pala (*Æpyceros melampus*) and the springbok (*Antidorcas euchore*) are inhabitants of the open plains, the latter formerly found in huge herds which made periodical migrations ("trek-bokken") across the country. Herds of considerable size may still be seen in certain districts. The splendid sable antelope (*Hippotragus niger*), which, with its sabre-like horns and dark coat is, perhaps, the handsomest of all antelopes, is not found south of the central Transvaal, and even there is now scarce. Still rarer is its larger cousin the roan antelope (*H. equinus*), though it has wider range. The southern representative of the group was the blaaubok (*H. leucophæus*), of which a few were left in Soete Melk (its headquarters) in 1781, but the last were shot about the year 1800.

The northern karoos of Cape Colony were the favourite haunts of that magnificent South African antelope, the gemsbok, or oryx (*Oryx gazella*), which fears not, if report be true, the onset of the lion, but the species is now very scarce, although a few still linger on the plains south of the lower course of the Orange River. Although the elegant little striped bushbuck (*Tragelaphus scriptus*) is still fairly common in many parts of the country, the lordly kudu (*Strepsiceros capensis*) survives in Cape Colony only in the jungles of the Uitenhage range, where it is protected by British farmers; while the larger eland (*Taurotragus oryx*) has been exterminated from nearly all the territories likely to be visited by the members of the British Association.

Other Big Game.—Among game animals other than antelopes, we may refer to giraffes, of which the Cape form appears to be already exterminated; the hippopotamus, now becoming scarce even in many parts of the Zambezi; the ugly wart-hogs, with their enormous tusks, and their relatives the bush-pigs, easily recognised by their tufted ears. In the horse tribe, the true quagga (*Equus quagga*) of the plains south of the Orange River, and apparently the typical race of the bonte-quagga or Burchell's zebra (*Equus burchelli*), from the north of that river, have already succumbed to the skin-hunters, but other races of the latter species occur further north. The great white rhinoceros, which used to charge the wagons of the pioneer hunters in mistaken apprehension of four-footed enemies, survives only in the shape of a few head specially protected in N.-E. Mashonaland, and perhaps by others near the junction of the White and Black Umvlosi Rivers, and would, indeed, have been practically extinct had it not unexpectedly been discovered on the equator.

General Mammal Fauna.—Of mammals other than big game, and apart from lions and leopards, that are especially characteristic of the country, the following may be mentioned: The spotted hyæna, the aard-wolf or maned jackal, the black-backed jackal, the fennec fox, the hunting dog, and the long-eared fox; various mongoose-like creatures, such as the meer-cat; the great South African baboon; the curious aard-vark or ant-bear, one of the most extraordinary of all mammals; and, among smaller forms, the strange golden moles, so named from the metallic sheen of their fur, and the great strand-mole from the sand-dunes in the neighbourhood of Cape Town. The Cape klip-dass, anglicized by the Colonists into "dassie," is interesting as being the southern representative of an African group with one out-lying Syrian member, as to the real affinities of which naturalists are still somewhat undecided.

Some South African Birds.—To enumerate even a tithe of the birds that deserve mention here would be impossible, but there are a few types, some of which call for comment.

It is worth travelling far to see, for example, such birds as the penguin and the ostrich in a wild state. Both flightless types, we have in the one a good illustration of degeneration, and in the other of the substitution of organs, the wings playing the part of the feet when swimming.

Though the ostrich is no longer to be found in a wild state in Cape Colony, it will probably be met with by those members of the Association who propose to make their way northwards into Rhodesia. Occasionally travelling in groups of from thirty to fifty, and then generally associating with zebras or some of the larger antelopes, this bird more commonly lives in companies of not more than four or five, that is to say, the males appear to live apart, accompanied by their mates.

The actual facts as to the breeding habits of the ostrich do not seem to have been definitely settled. But it would appear, according to Professor Newton, that the females lay their eggs in one nest—a shallow pit scraped out by the feet, the earth so displaced being used to form a wall around the eggs. As soon as ten or twelve eggs have been laid brooding commences. The cock performs this duty by night, his black plumage serving as an admirable protective dress at the time: the females seem to take up this duty in turns by day. Being soberly clad they harmonise with the sandy plains under the glare of the sun. About thirty eggs appear to be laid in the nest, and around it as many more are scattered, which are commonly believed to be used as food by the young. Brooding is believed to be resorted to, by day at least, not so much for the purposes of incubation as to protect the eggs from prowling jackals. It is open to question, however, whether this interpretation is correct, for it is quite possible that by day protection from the sun is absolutely necessary.

Those privileged to visit an ostrich farm may be likely enough to see an old cock bird "roll." This peculiar form of display is adopted preparatory to giving battle to a rival when courting. Suddenly bumping down on his "knees," he will, says Mr. Cronwright Schreiner, "open his wings . . . and then swing them alternately backwards and forwards . . . as if on a pivot. . . . The neck is lowered until the head is on a level with the back, and the head and neck swing from side to side with the wings, the back of the head striking with a loud click against the ribs, first on one side then on the other. The click is produced by the skin of the neck, which then bulges loosely out just under the beak and for some distance downwards, and while "rolling" every feather over the whole body is on end, and the plumes are open like a large fan. At such a time the bird sees very imperfectly, if at all."

The chances of meeting with the secretary bird (*Serpentarius secretarius*) in Cape Colony are by no means so certain as before the war. It is one of the most peculiar of the birds of prey, and one of the most primitive; albeit, in many respects, highly specialised. It is remarkable for the length of its legs and the tuft of long feathers resembling quill pens, which grows out from the sides of the head—hence the name "secretary bird." It feeds largely on venomous snakes, and on this account is supposed to be strictly protected. The prey is killed by means of blows from the wings, followed by vigorous pounding with the powerful feet. There seems, unfortunately, to be a tendency to relax the protection hitherto accorded these birds on the plea that they also eat animals coming under the head of "game." The secretary bird builds a huge nest of sticks, placed on the tops of low bushes. In the interstices of the nests colonies of sparrows breed, quite unmolested by their powerful overlords. In Cape Colony the deserted nests of the secretary birds are now being appropriated by the Stanley crane. The young remain helpless in the nest for a period as long as six months, and for a considerable time after leaving this they are in danger of snapping their long legs, which appear to be very brittle, the body, as large as that of an eagle, being heavy.

Of the other birds of prey we have no space to speak. Many will see eagles and vultures for the first time during the visit.

The Hammer-head, a peculiar and aberrant stork of small size and sombre colour, is one of the curiosities of Cape Colony. Among the Dutch element it is known as the Hammer-kop. This bird, though scarcely larger than a raven, builds an enormous nest, which may be as much as six feet in diameter, and placed either in the fork of a tree or on a rocky ledge. It is made of sticks, roots, grass and rushes, and it is remarkable for the fact that it is roofed over and neatly lined with clay, thereby differing from the nests of all other members of this order.

Hoopoes and Hornbills, if fortune be kind, may, perhaps, be met with. Of the former the most likely to be encountered is a species closely resembling that which occasionally has the temerity to visit the British Islands. The Cape species in question is U. *Africana*. Flocks of the beautiful Wood-hoopoe (*Rhinopomastus*) flitting from bush to bush, resplendent in metallic purple but lacking the crest of its more familiar ally Upupa, may also be looked for. Handsome and useful as these birds are, they are remarkable for their evil smell and the foul condition of their nests. The former appears to be due to a secretion of the oil gland of both old and young, and in this respect the Hoopoes appear to be unique among birds. Is is said that the South American Hoatzin possesses a similar secretive power.

Hornbills are less likely to be seen, and these will only be representatives of the curious ground hornbill, the "Brom-Vogel" of South Africa. This bird is unique among the hornbills for the great length of its legs, an adaptation to a more or less terrestrial life. The Kafirs have a tradition that drought will cease if one of these birds is sunk under water and drowned. Nearly all the hornbills are remarkable for the noise made during flight, which has been likened to that of a steam engine. The "Brom-Vogel" is said to be capable of uttering a note resembling a lion's roar, and audible for a mile.

The hornbills have unique nesting habits, the female retiring to a hollow tree and being walled in by the closing up of the entrance to the hole with dung, some say by the male alone, others say by the efforts of both birds, their own dung being used for this purpose. In the Bornean hornbill, at any rate, this plaster is, how-

ever, not composed of dung, but of a substance said to resemble vegetable resin, and believed to be composed of a gastric—more probably salivary—secretion combined with the woody fragments of fruit. During her incarceration the female is fed by the male, who, for this purpose, brings up the contents of his gizzard enclosed within the inner lining of this organ.

Parrots and Touracoes may be met with, and so also may the curious Coly or Mouse-bird, and the celebrated Honey-guide (Indicator), which, like many cuckoos, is parasitic.

A word as to Cape pigeons and penguins, which will be the first of the many new birds which will greet the eye of those who are making their maiden trip to South Africa. The Cape pigeon is, though so-called, not a pigeon but a petrel (*Daption capensis*).

The penguin is the species known as the Black-footed Penguin (*Spheniscus demersus*). These representatives of a really remarkable group are still numerous, and after the breeding season may be met with in huge flocks some fifty miles from land. Layard, in his "Birds of South Africa," describes these birds as having the "feet placed so far back as to cause the bird to appear always falling backwards if it attempts to stand on land." It is not easy to understand how such a statement came to be made, for it is well known that penguins of all species walk well, if not hurried. The penguin is an expert diver, using its remarkably transformed wings—which now resemble paddles superficially, hardly distinguishable from the paddles of the porpoises, for example—when under water, after the fashion of birds that fly, the feet being held backwards as in a bird in flight. The prey is caught and swallowed under water. Though it is not generally known, the nostrils of these birds have become obliterated, as in gannets and cormorants, so that breathing is possible only through the mouth.

The Extinct Reptile Fauna of South Africa.

The biological importance of the wonderful series of remains of extinct South African reptiles which has been gradually brought to light from the rocks of the Karoo system of Cape Colony, Griqualand West, and adjacent territories, hardly needs emphasis. Were it not for the discovery of this reptilian fauna a gap would have remained in that chain of animal evolution which it has been found possible to construct during the last few years. For, as a matter of fact, these marvellous Karoo reptiles actually supply the connecting link between the now widely sundered reptilian and mammalian classes; and without the evidence they afford it may be affirmed that not even the most ingenious and far-seeing of evolutionists could ever have realised how intimate and complete was the connection between these two groups in past times. Needless to say, the closeness of the relationship was by no means fully appreciated at the first outset; and although at an early stage of the investigation Professor Owen was enabled to point to a number of very remarkable mammalian resemblances, both in respect of their bones and their teeth, it was reserved for his successors to fully demonstrate that in these strange African reptiles of a bygone age we have the actual representatives of the ancestral stock from which mammals originated. Possibly even this does not fully emphasize the strength of the case in regard to the interest and importance attaching to these South African reptiles, for since they have representatives in other parts of the world, it might thereby be inferred that these non-African species would have supplied all the information that is really essential in regard to the kinship between mammals and reptiles. As a matter of fact, this is not the case; and there is a considerable probability that Africa, known to have existed as a continental area for a prodigiously long period of time, was really the nursery in which the mammalian type was first evolved from its reptilian ancestry, and that some of the African mammal-like reptiles already known to us are not far removed from being links between the two groups.

Science is indebted for the first discovery of their remains to the late Mr. A. G. Bain, an engineer who was employed in the early part of last century in the construction of military roads on the northern and eastern frontiers of Cape Colony. The actual first discovery appears to have been made by him in 1838, in a spot situated somewhat to the north of Fort Beaufort, near Mildenhalls. A letter from Mr. Bain, dated Fort Beaufort, April 28, 1844, addressed to the Geological Society, records the discovery. Accounts also appeared from time to time in local journals at the Cape, in some of which it is mentioned that Mr. Bain's attention was first attracted by portions of bone projecting from the rock.

After being cleared from matrix, and thus made available, the fossils were described by Professor Owen as a kind of appendix to Mr. Bain's "letter." Mr. Bain, in the latter, referred to the most remarkable of his fossils under the name of "bidentals," in allusion to the single pair of large tusk-like teeth with which the upper jaw is armed, and it was to a skull of this type that Professor Owen gave the name of Dicynodon.

In 1852 Mr. Bain sent another large consignment of reptilian fossils to our Geological Society, which, on the advice of the Professor, were subsequently transferred to the British Museum, together, apparently, with the first collection.

The interest aroused by Professor Owen's description of these remarkable reptiles, as well as by his references to them in lectures delivered before the Royal College of Surgeons, was very great. Among those specially interested was the late Prince Consort, who impressed upon his son, the late Prince Alfred (afterwards Duke of Edinburgh), then about to travel in South Africa, the importance of endeavouring to obtain additional specimens. This advice was not neglected, and on his return from South Africa in 1860, Prince Alfred forwarded Professor Owen two skulls, which were described by the latter in the "Philosophical Transactions" of the Royal Society for 1862. One of the skulls, which belonged to a genus nearly allied to Dicynodon, indicated a new species, and was named *Ptychognathus alfredi*, in honour of the royal collector.

Previous to this, Sir George Grey, then Governor of Cape Colony, had also become interested in these discoveries; and it was to him that Professor Owen was indebted for the first example of a representative of the carnivorous section of these reptiles. Mr. Thomas Bain, son of and successor to the original collector, was likewise an energetic worker, and as time went on important collections of these fossils were brought to-

gether in the museums at Cape Town, Graham's Town, and Albany. Among other energetic collectors, special reference must be made to the late Dr. W. G. Atherstone, who devoted much time to the advancement of our knowledge of South African geology and palæontology, and to Mr. Alfred Brown, of Aliwal North, the possessor of a magnificent collection of fossil reptiles, the result of over forty years' assiduous labour.

Although Professor Owen was the first to describe and name the remains of these extinct reptiles, several other workers have followed him in this line of investigation. A foremost place must be assigned to Professor H. G. Seeley, F.R.S., who made a journey to South Africa for the express purpose of collecting specimens and studying those in the local museums, and who subsequently published the results of his investigations in the "Philosophical Transactions." The relations of these reptiles to mammals formed the leading feature in Professor Seeley's investigations. More recently Dr. R. Broom, now resident in South Africa, has studied the nature of these fossils.

Soon after the first representatives of the reptilian remains were obtained it was recognised that the rocks in which they were entombed formed an extensive series of freshwater deposits, for which the distinctive title of Karoo system was selected; the chief reptile-bearing horizons being those known as the Beaufort and the Stomberg beds. It should be added that in addition to the remains of reptiles, these beds contain ferns of the genus *Glossopteris*, and that freshwater deposits similarly containing *Glossopteris*, and in some cases also Dicynodont reptiles, have likewise been met with in India, Australia, and Argentina. Hence it has been inferred that in early times the so-called "Glossopteris flora," with its associated animals, formed a zone round the world, lying to a great extent in low latitudes.

The next question was to determine the age of the Karoo system and its equivalents in other parts of the world. As the result of much discussion, it is now generally admitted that this corresponds in the main with the Trias, or Upper New Red Sandstone of Europe, although some of the lower beds in the series may represent the underlying Permian, or the beds which, in Europe, immediately overlie the Coal-Measures, and thus form the uppermost division of the Palæozoic system, as the Trias constitutes the base of the Mesozoic.

The rocks of the Karoo system consist for the most part of more or less merely horizontal strata of sandstones and shales, ranging from 8,000 to 10,000 feet in thickness, and extensively traversed by outflows of igneous rocks. These intrusive sheets consist of the rock known as dolerite, and form flat table-lands rising above the general level of the Karoo, giving rise to the numerous "Tafelbergs" (table-mountains) to be met with in this part of South Africa.

It now remains to consider briefly the special features of the South African Karoo reptiles which render them of such remarkable interest and importance to the evolutionist. In this connection it has to be mentioned that there is a certain amount of difference of opinion in regard to the best collective name for these reptiles. In one of his earlier papers, Professor Owen proposed the name "Anomodontia" for the Dicynodonts and a certain British extinct reptile with which they have no real affinity. In a later work ("Palæontology") published in 1861 this name was, however, taken to include not only these Dicynodonts, but also the carnivorous types, although the definition was retained in the original sense as being applicable only to the Dicynodonts and associated forms.

According to modern views, these Anomodont reptiles represent a branch of reptilian stock (the Theromorpha), equal in value to a second branch (Ornithomorpha), which includes all other reptiles both living and extinct. This indicates succinctly the real importance of the Anomodonts, which seem to have been derived from the earlier Permian salamander-like creatures known as Labyrinthodonts, and which have certainly given origin to mammals. On the other hand, the second reptilian branch, which gave origin to birds, seems to have sprung from an entirely different group of primeval salamanders—the Microsaurians. It should be added that it is to the egg-laying mammals of Australasia (Monotremata), as represented by the duckbill or platypus, and the echidna or spiny anteater, that the Anomodont reptiles present the closest resemblance. These egg-laying mammals are, however, evidently specialised and aberrant forms, and it is, consequently, to their extinct and more generalised ancestors (which we may never discover) that we must look as constituting the direct links between reptiles and mammals. Still, as it is, the connection between the two groups is so close that some of the Anomodonts have actually been described as mammals.

To render the resemblances existing between Anomodonts and the Monotreme mammals apparent to the general reader, without the aid of illustrative diagrams, is, of course, a difficult matter. It may be mentioned, however, that the transition between the complex lower jaw of an ordinary reptile, articulated to the skull by means of a quadrate-bone, and the simple jaw of a mammal, which has no such intermediate connection, is exhibited by the Anomodonts; which also show how the tripartite knob, or condyle, forming the articulation of the skull with the vertebral column, passes into the paired knobs, or condyles, of the mammal. The bones of the pelvis and shoulder-girdle (shoulder-blade, coracoid, etc.), are, again, essentially similar in Anomodonts and Monotremes, and quite different from those of other reptiles; and a similar resemblance is noticeable in the form and perforations of the humerus or arm-bone, and in regard to the structure of the wrist and ankle joints. In a word, the difficulty is, not to discover resemblances, but to point out differences between the Anomodonts and the Monotremes, although the more typical representatives of the latter are undoubtedly reptiles in the strictest sense of that term.

Anomodonts are divisible into the following distinct groups. First, the Dicynodonts, in which the males (Dicynodon) are typically provided with a single pair of tusks in the upper jaw, while the females (Udenodon) were toothless; other forms having, however, crushing teeth on the palate; secondly, the Carnivorous, or Theriodont, type, like *Galesaurus*, in which the whole skull and dentition is marvellously mammal-like; thirdly, the Cotylosauria, in which the hinder part of the skull was partly roofed over; and, fourthly, the Pariasauria, in which the whole skull was roofed and its bones sculptured, so that the resemblance to a labyrinthodont salamander becomes exceedingly close. Some of these creatures, notably Pariasaurus, certain species of Dicynodon, and a few Theriodonts, were of enormous bodily size—as large as crocodiles.

The Zambezi and its Sights.

No longer can it be said that the Victoria Falls are inaccessible, for now luxurious corridor trains are running made up of sleeping, dining and buffet cars, fitted up with library, writing room, bath rooms, observation platforms, and other accessories, performing the journey from Cape Town in three-and-a-half days, or from Beira in two-and-a-half days.

At a point some two miles before the end of the journey is reached, a fine view is obtained of the broad level valley of the Zambezi river, with the deep and precipitous Grand Cañon, zig-zagging like the path of a lightning flash for over forty miles through the hard basalt; while beyond is seen a glimpse of the calm broad river gliding peacefully towards the great chasm, whose presence, though hidden by the dark green foliage of the adjacent Rain forest, is clearly marked by a wall of whirling spray.

Long before reaching the falls columns of spray can be seen rising like clouds far into the air, and when, at intermediate stations, the train comes to a standstill the ear receives a dull distant roar of sound.

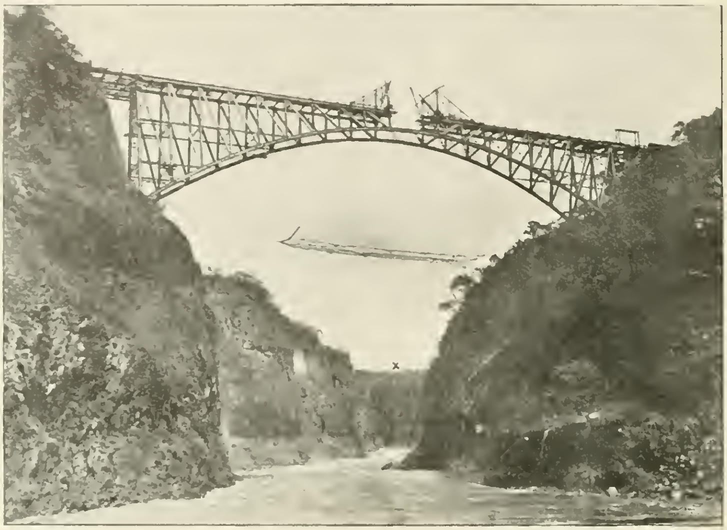

Fig. 2.—The Zambezi Railway Bridge across the Grand Cañon. The Roof of the hotel at which the Members of the Association will stay is just visible under the cross.

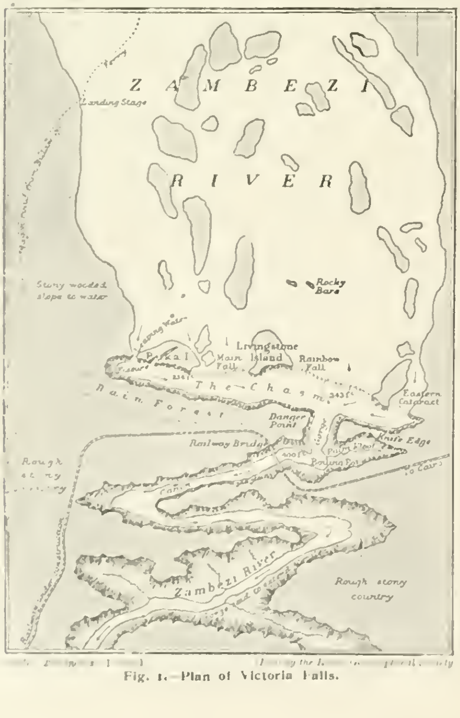

Fig. 1.—Plan of Victoria Falls.

A glance at the accompanying plan (Fig. 1) is necessary to enable the geography of the river to be clearly understood. The mile-wide expanse of calm water, broken by numerous islands, is terminated suddenly by a long, narrow chasm stretching at right angles across the river; in wild, tumultuous foam of dazzling whiteness, this mass of water is hurled down some 260 to 380 feet with the roar of thunder into the dark depths, the very earth trembling from the incessant blows. The air drawn down by this irresistible volume of falling water, catches up the broken spray and whirls it in drenching gusts far above to form the cloud-like columns, which have been computed (by theodolite) during the rainy season as rising to a height of three thousand feet. From out the chasm there is no exit, except at a point about two-thirds of the distance across the river, where the opposite wall of basalt has been broken through in a narrow gorge. Gathered at this spot and contracted to less than 100 feet in width, the river here enters the Boiling Pot, so called, not because of its turbulence, but, on the contrary, from its placid swirling surface, that is broken only by countless air bubbles which rise from the depths of the main current. At the lower end or lip of the Boiling Pot the waters emerge in the form of a huge mill-race, which dashes itself against the precipitous wall of the cañon, half going to form the whirlpool at the foot of Palm Kloof, while the remainder, flowing at right angles to its former direction, rages between these stupendous cliffs for over forty miles.

When the river is low, small craft, if carefully handled, can approach to within a hundred yards of the lip of the falls at poins where the current is not swift.

It was in this way that Livingstone, who first visited the scene, came down stream in a "dug-out," landing on the island, which bears his name (see Fig. 1), and which is perched on the very brink of the chasm and almost in the middle of the falls. The views obtained from this point are by far the finest and most impressive, and for this reason it is well worth the while of visitors to refrain for the first day from stopping at the well-placed hotel on he south bank of the river, and to continue the journey until the new township of Livingstone on the north bank is reached; by doing this a glimpse only is caught of the cañon and falls while crossing the bridge, but it is a foretaste of what is to come. Then, chartering a boat on arrival, the quiet beauties of the upper river may be enjoyed while gliding down stream until Livingstone Island is reached. The remembrance of the first view from this vantage point will ever remain in the mind's eye.

Visitors are accustomed to stop on the south bank, where a comfortable and well-managed hotel has been erected by the Rhodesia Railways. From here it is but half a mile to the west end of the chasm, and all the wonders of this masterpiece of nature can be readily approached.

The Zambezi above the falls, save for a few rocky bars causing small rapids, is a beautiful wide river, flowing for many miles and dotted with numerous islands, which are thickly covered with tropical vegetation, forming a habitation not only for an infinite variety of waterfowl, but also for the treacherous crocodile and the bellowing hippopotamus. Game, too, is plentiful along its banks, and the tiger fish affords as good sport as the salmon. A particularly fine open reach about a mile above the falls has lately been the scene of a first regatta.

The bridge (Fig. 2) now completed, carrying the projected Cape to Cairo Railway, spans the Grand Cañon at a point just below the whirlpool, and is placed so as not to interfere with views of the falls. Far from being an eye-sore, the structure is of light and graceful design, eminently fitted for its purpose and to the locality; moreover, it seems to enable one to realise all the better the great depth of the gorge and the enormous scale on which Nature has wrought her work.

It consists of one main parabolic arch of 500 feet span, resting on blocks of concrete set in the sheer cliff, and, with two subsidiary end spans, the total length is brought up to 650 feet. The whole is supported on four steel bearing pins six feet long and 12 inches in diameter, and each pin takes a load of 1,640 tons.

Scaffolding being, of course, impossible, the bridge was made to support itself, as the two halves were built outwards. This was effected by attaching cables

Photo by Pedrotti, Bulawayo.

Fig. 3.—The Victoria Falls. The Main Fall at low water, as seen from Livingstone Island.

to the steel work and anchoring them back in the solid rock behind, and as the electric cranes standing on the completed portion built the bridge forwards, extra cables were affixed until, on April 1st last, the two halves met.

The process by which the Zambezi has cut its erratic course has been traced by Mr. A. J. C. Molyneux in the *Geographical Journal*.* The basalt rock, when cooling, developed cracks and fissures, due to contraction, and assumed the columnar form. The cutting back of the falls is concluded to be due to the water falling down upon and into these cracks; with the constant vibration the columns are rent asunder and fall in huge flakes into the chasm. Little evidence is seen of the rock being worn away by attrition, the blocks newly fallen into the chasm still retaining their sharp angles. These blocks gradually disappear into the Grand Cañon impelled by the rush of the current, and are constantly grinding down and deepening the bed, to emerge as rounded pebbles at the eastern end.

The zigzags are held to be due partly to the position of the islands that studded the river (as now), and to the existence of master joints and fissures in the basalt. Where an island occurs there the erosive action of the water has no effect, hence the extraordinary isolated bluffs and knife edges of rock connecting them. There are no signs that the earth was cracked in this form by some seismic convulsion, or that a material softer than the surrounding basalt has been eaten away by the action of the water.

One of the chief glories of the falls is the wealth of colour, not only in the rich foliage of the tropical vegetation, or the dazzling white masses of tumbling foam, but in the prismatic bows sparkling in the mist. When walking between the forest and the chasm, a small bow may be seen almost within touch of the hand, and faithfully following; then there is the more ordinary type spanning the gorge or irradiating the gloomy depths below, and rendered especially beautiful by the soft rays of the moon.

Many members of the British Association who are visiting South Africa intend to travel as far north as the Zambezi. The climate at that season of the year will be found dry and warm, while mosquitoes and fever are happily absent. The volume of water, too, has been diminishing since May, consequently the curtain of spray will be in great measure drawn aside, disclosing the beauties of the falling water and the depths of the chasm.

* Vol. xxv., No. 1, 1905.

South African Association for the Advancement of Science.

From a suggestion to arrange for an Annual Congress of Engineers in South Africa arose the larger idea of a federated body in science on the model of the home British Association. The first practical step was taken in March, 1901, at a meeting held in Cape Town, Sir Charles Metcalfe presiding. The main impetus to the movement for such an organisation was given by Mr. T. Rennert, M.Inst.C.E., a resident of Johannesburg, and he, indeed, may be regarded as the father and founder of the South African Association. The first meeting was held at Cape Town in 1903, under the Presidency of Sir David Gill, with a membership of 700, since increased to over 2000; the second at Johannesburg, Sir C. Metcalfe, presiding. No meeting is to be held in the present year.

The Royal Observatory at the Cape.

The first official document relating to the Royal Observatory at the Cape of Good Hope is a minute of proceedings of a meeting of "Commissioners appointed by Act of Parliament for more effectually discovering the longitude at sea," it is dated February 3, 1820. The establishment of an observatory was proposed at this meeting by Mr. Davies Gilbert, M.P., and seconded by Sir Joseph Banks, P.R.S. By an Order in Council authority was given on October 20, 1820, for the establishment of a staff, consisting of an astronomer and

Photo by Maull & Fox.

SIR DAVID GILL, K.C.B., F.R.S.,
H.M. Astronomer at the Cape of Good Hope.

assistant astronomer. The equipment was a 25-feet zenith micrometer by Troughton, a transit by Dollond, a 6-foot mural circle by Jones, and an equatorial sector and a 6-feet Newtonian reflector were provided from Greenwich. Although the primary object in founding the observatory was to provide ships sailing to India and the East with accurate time, it was recognised that a suitable opportunity had presented itself for founding a great national observatory in the Southern Hemisphere. The first astronomer was the Rev. Fearon Fallows, F.R.S., who arrived at the Cape in 1821, bringing with him some portable instruments. His first instructions were to find a suitable site. The present one, it should be said, was chosen after trying several others, which had to be abandoned on account of drifting sand or of cloud, and many were the annoyances and discomforts encountered during these preliminary efforts. For over three years Fallows lived in a hut superintending the building of the observatory. At last, in 1829, he found it possible to begin regular astronomical work, but he could not accomplish much

through want of proper assistance. Before his death, in 1831, he had observed over 3,000 transits, and had made several hundred circle observations, which were subsequently reduced by Airy. Thomas Henderson, who succeeded Fallows, remained at the Cape for 14 months, but in that short time he had made a large number of first-rate observations, the most important being meridian places of α Centauri, from which he found a parallax of about $1''$.

Highly valuable observations were made by the next astronomer, Sir Thomas Maclear (1834 to 1870), but owing to inadequate assistance the reduction of a large part of them had to be left to his successors. Mr. E. J. Stone, F.R.S., who succeeded him, received, however, instructions to reduce them as quickly as possible, and from these observations three star catalogues have been formed.

In 1879, when Mr. (now Sir) David Gill took up his duties, there were only three assistants on the staff and three or four computers, the latter on the same footing as at Greenwich; now the scientific staff numbers 12, with 10 to 15 male and female computers. The instrumental equipment, too, has been greatly increased. In 1880 it consisted chiefly of the transit circle and a 7-inch equatorial, but the additions since that date include the Victoria telescope, the gift of the late Mr. F. McClean, F.R.S., a new and specially designed transit circle, an elaborate astronomical clock recently installed, an astrographic telescope, employed chiefly on the international "Carte du Ciel," a 7-inch heliometer, and numerous smaller instruments.

Of the work already completed by Sir David Gill, perhaps the most important is the determination of the solar parallax from observations of the minor planets Victoria, Sappho, and Iris. Over 20 observatories contributed towards this work, and at the Cape, where nearly all the reductions were made, more than 16,000 observations were made with the heliometer. The result is a solar parallax of nearly $8''\cdot80$, corresponding to a distance of the earth from the sun of 92,874,000 miles, a value generally adopted in national Ephemerides. We may refer also to the compilation of three large star catalogues, the reduction of Maclear's observations, the determination of stellar parallax with the heliometer, the work done with the astrographic equatorial for the "Carte du Ciel" and for the "Cape Photographic Durchmusterung." The latter is a catalogue containing the places, reliable to $1''$, and magnitudes of 454,875 stars from declination -19° to the south pole. Some 2,500 plates were taken for this, and the arduous work of measuring them and making the catalogue was undertaken by Prof. Kapteyn. During the course of measurement a great number of interesting variable stars were detected, also a star with the greatest known proper motion. The measurement of the plates, which is still going on, is entrusted to ladies. So far about 800 plates have been measured, containing nearly half a million stars.

Another piece of work under Sir David Gill's supervision is the partly-completed geodetic survey of South Africa.

The Victoria telescope and accessories, with the dome and attached laboratories, was the gift of Mr. McClean, and is devoted to the study of astrophysics. The dome is provided with a rising floor which is worked by hydraulic machinery. The telescope itself consists essentially of two parallel tubes tied together, one for a 24-inch photographic lens, the other for an 18-inch visual; and there can be attached to it two large objective prisms or a large slit spectroscope for determinations of velocity in the line of sight. Many interesting spectra have already been photographed and measured.

The new transit circle has been specially designed to be free from the effects of temperature change, and is being used to make the most refined fundamental observations. It can be readily reversed in its trunnions, can have the object-glass end and the eye end interchanged, and is fitted with Repsold's micrometer with moving wire for observing transits. To bring this installation into proper working order and to determine all such instrumental constants as division errors of the circles, periodic errors of screws, and other details, necessarily consumes time and demands much patience, but in his last report, His Majesty's astronomer stated that "the new transit circle will be brought into regular catalogue observing work from the beginning of 1905." The old transit circle is still in use for the time service, an important part of the observatory's work. The instant of Greenwich noon is signalled every day to Simon's Town, Cape Town, Port Elizabeth, and East London, and all the railway clocks on the Wynberg line are automatically set every hour, a system which is being extended to other portions of the Government railways.

To provide fixed meridian marks for azimuth reference, deep pits have been sunk, and on the bed rock at the bottom of them the marks rest. A clock for use in connection with the new transit circle has also been installed, the pendulum of which swings in an air-tight case, in which the air is automatically kept at a uniform pressure and temperature.

The South African Museum, Cape Town.

The only institution connected with zoology in South Africa which is provided with a scientific staff and is doing original work, apart from the mere acquisition and arrangement of specimens, is the South African Museum at Cape Town. This museum was founded by the late Sir George Grey when Governor of the Colony in 1855, and its first Curator was Edgar Leopold Layard (a brother of Layard of Nineveh fame), who was well-known as an enthusiastic naturalist. Layard was the author of many books and papers on zoology, and likewise an excellent field-naturalist. His best known book is his "Birds of South Africa," of which the first edition was published in 1867. The second edition, in preparing which Layard was assisted by Dr. Bowdler Sharpe, was completed in 1884, and has until quite lately been the recognised book of reference on South African ornithology.

In 1872 Layard left the Cape to take up a consular appointment in New Caledonia, and was succeeded by Mr. Roland Trimen, F.R.S., distinguished as an entomologist, and especially for his knowledge of the Lepidoptera. Mr. Trimen held the appointment for 23 years. His excellent work on the butterflies of Cape Colony and surrounding districts

("Rhopalocera Africæ Australis") will always render his name well known in the annals of African zoology.

In 1895 Mr. Trimen resigned his appointment for reasons of health, and in December of that year Mr. William Lutley Sclater, at that time a science master at Eton College, was selected by the trustees to succeed him, and was appointed Director of the Museum.

Mr. Sclater arrived at Cape Town in March, 1896, just in time to preside at the removal of the collections from the old quarters in which they had been previously kept, to the new and commodious building which had been completed in 1895, and which is situated in the public garden in the best part of Cape Town near the Cathedral and House of Parliament. The building is of two storeys, the ground floor being devoted to the geological and mineralogical collections and the invertebrata, and the upper floor to the exhibition of the mammals, birds, reptiles, and fishes of South Africa, of which there is a very good illustrative series, though many *lacunæ* remain to be filled up. Mr. Sclater, besides his general duties as Director, has charge of the collection of vertebrates. As regards the invertebrates, he is ably assisted by Mr. L. A. Péringuey, the Assistant Director, who is a well-known authority on Coleoptera and other insects. The first assistant, Dr. W. F. Purcell, who is also well known for his original researches on the scorpions and spiders of South Africa, has charge of a portion of the invertebrata. A fourth member of the zoological staff is Dr. J. D. F. Gilchrist, who is honorary keeper of the marine invertebrates, but whose main duties are to develop the fisheries of the Cape seas, which are under the charge of the Agricultural Department of the Colonial Government.

The keeper of the important department of geology and mineralogy at the South African Museum is Dr. G. S. Corstorphine, who is associated with Mr. E. H. L. Schwarz, of the Geological Survey of the Colony, and they have the care of the fossils and other specimens collected by the Survey.

Two good pieces of work have been started by the present Director since his appointment. These are a series of manuals on the fauna of Africa south of the Zambezi, and a periodical called "Annals of the South African Museum." Of the first of these the two volumes on the mammals were prepared by Mr. Sclater in 1900 and 1901.

The "Birds of South Africa" was entrusted to the late Dr. Stark, a well-known authority on the subject, and the first volume was published in 1900. But Stark, who volunteered for the medical service of the English Army, unfortunately lost his life in the siege of Ladysmith, and the second and third volumes on the birds have been written by Mr. Sclater, with some assistance from Stark's field notes. The fourth volume concluding this work is now in the press.

The "Annals of the South African Museum" contain scientific memoirs, prepared mostly by the members of the official staff of the Museum or other naturalists working with them. Two volumes and twelve parts have already been issued.

Naturalists will see, therefore, that much good work has been done in the South African Museum, and that more is likely to come from it. We should also be grateful to the three Trustees of the Museum, Mr. Merriman, Sir David Gill, and Dr. T. Muir, Superintendent-General of Education, three well-known personages in Cape Town, who have assisted in every way the efforts to increase the usefulness of the institution.

Star Map—No. 12.

The South Polar Region.

THIS map, though not issued in its proper order of sequence (Nos. 1, 2, and 3 having appeared in the last three issues of "KNOWLEDGE"), may be useful to those visiting the Southern hemisphere.

The Southern Cross (Crux) is always considered as the ruling constellation of austral skies. It is situated in the Milky Way, just to one side of the "Coal Sack," a space quite devoid of stars. Another group of stars of very similar arrangement (ϵ and ι Carinæ, with δ and κ Valæ) are often mistaken for it, and is consequently known as "The False Cross."

Two peculiar objects are the Great and Little Magellanic Clouds, looking like detached portions of the Milky Way. Examined with a powerful telescope, these are found to consist of masses of star clusters and detached nebulæ, and would seem likely to be altogether separate "universes" at a vast distance off.

Around the actual South Pole is a noticeable absence of conspicuous stars, and though this feature alone enables one to judge of the general position, it is more difficult to recognise the true South from the stars than it is to find true North when Polaris is visible. Yet beyond 20 to 30 degrees from the Pole occurs a number of bright and easily recognised stars. The upright shaft of the Southern Cross points nearly North and South, and the line being continued through the South Pole, runs into the Little Magellanic Cloud. To be more exact, however, one should continue this line further, and thus find Achernar (α Eridani). A line joining this with β Centauri (the nearer of the so-called "pointers" to the Southern Cross) runs directly through the South Pole, which is just about midway between the two. Among the more specially interesting objects in this region are:—

Cluster 47 Toucani (oh. 20m. — 72° 39′). A fine star cluster visible to the naked eye as a hazy star. Over 2000 stars, including 6 variables, are included in it.

α *Crucis* (*Acrux*) XII.h. 21m. — 62° 33′) is a triple star. Magnitudes, 1·5, 1·8, and 6.

κ *Crucis* (XII. h. 43m. — 59° 30′) is a cluster of over 100 stars. They are of many different colours, and present a beautiful sight in a good telescope.

α *Centauri* (*Rigil al Kentaurus*) (XIV.h. 23m. — 60° 26′) is well known as being the nearest star. Yet its distance is not easy to realise. It is computed to be about two hundred thousand times the mean distance of the Sun from the earth. The light takes over $3\frac{1}{2}$ years to come to us. This star has a parallax of 0″·75. It is a binary, the two stars being at a distance of 21″·6, and of nearly equal size.

α *Argus* (*Canopus*) (VI.h. 21m — 52° 38′) is the second brightest star in the heavens, being classified at — 1·0 magnitude.

η *Carinæ or Argus* (X.h. 41m. — 59° 10′) is a most peculiar variable. Two hundred years ago it was of the 4th magnitude. In 1837 it increased in brightness till it became a 1st magnitude. It then diminished a little, but six years later had a brilliancy comparable to that of Sirius, after which it gradually dwindled away to the 7th magnitude. It is surrounded by a remarkable nebula, known as the "Keyhole" on account of the well-defined dark opening in its centre.

Quite recently careful photographic surveys have been made of the Small Magellanic Cloud at the Arequipa Observatory. These prove the existence of a very large number of variable stars, there being within this region a proportion of one variable to every 308 stars, which is nearly ten times the ordinary proportion. One star of the 13th magnitude was found to have a proper motion amounting to + 0·13 s. in R.A., and + 0″·42 in Dec.

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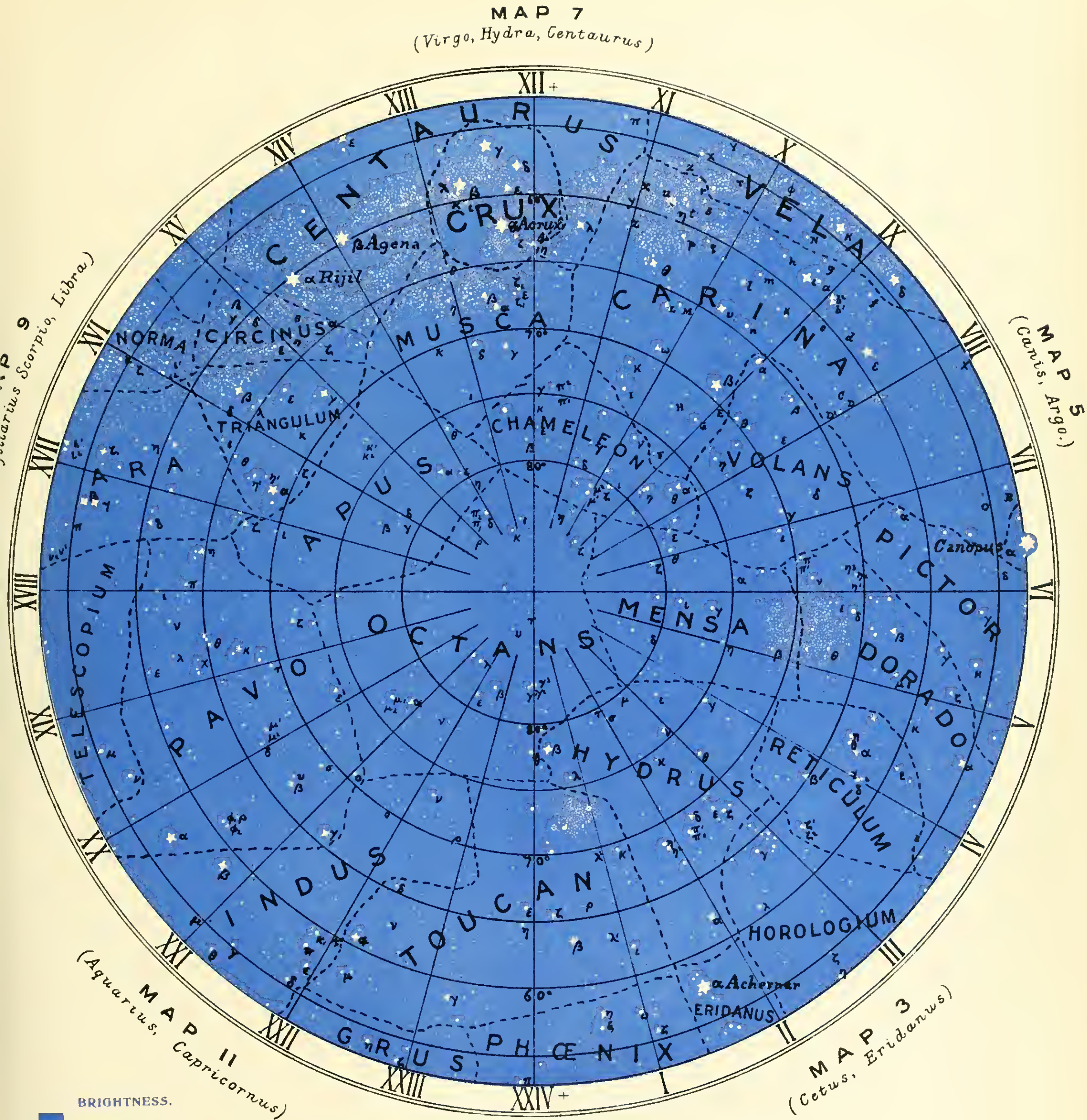
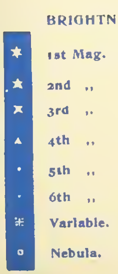
(British Association Meeting.)





MAP No. 12.

The South Polar Region.

Photography Abroad.

Camera Work for Travellers.

Doubtless a large number of the members of the British Association who will go to South Africa, purpose taking cameras with them in order to bring home records of their visit. Many of them will be experienced photographers who know exactly what they want and how to get it, but there will certainly be others who have done little if any work of this kind before, and some may hesitate as to whether it is worth while to run the risk of failure, seeing the expense and trouble that would be incurred. Accordingly it is to the inexperienced that these notes are addressed.

The uncertainty and difficulty that used to beset photography abroad have almost disappeared. The experience by which we are now able to profit, and the efforts of manufacturers to make everything easy, have reduced the practice of photography, such as is here referred to, to the simplest of operations wherever it may be carried on. No one, therefore, need hesitate to take a camera for fear their trouble will be wasted.

But it is necessary to note that apparatus and methods that would well serve, and, indeed, best serve, if photography were the primary object of the visit, would not only be out of place and a constant source of annoyance, but quite impracticable under the existing circumstances.

Apparatus, its Weight and Bulk.—We have often been told by persons about to travel, that weight is scarcely worth consideration, and that bulk, too, is a minor matter, because the luggage is carried by servants; but that rough usage must be guarded against, for packages are sure to be knocked about. In the present case, however, these circumstances will be reversed. Each will carry his own camera and be able to take reasonable care of it; therefore, weight and bulk become very important items. This at once excludes all box cameras and non-folding apparatus; except, indeed, for the enthusiast regardless whether his photography prove a burden to himself, and perhaps also a nuisance to other people. There are many very small cameras that may be exceptions to this generalisation, but we have in view the production of photographs not smaller than about quarter-plate size, $4\frac{1}{4}$ x $3\frac{1}{4}$ inches.

In judging of weight and bulk, it is important to consider two distinct things, namely, the apparatus that has to be carried about when in use, and also the apparatus and material that will be left at the hotel, such as the stock of sensitive material, developers, and so on. Concerning the latter, little need be said, but purchasers are often deceived as to the portability of the camera and what must be taken with it whenever it is to be used. There is no gain in having a compact and light camera if it has to be carried in a large and heavy case. The apparatus must be judged of when in exactly the condition in which it will come into play, with everything ready for making a series of exposures. If any part is loose, such as a changing box, backs, or other contrivances for carrying the plates of films, this part must be included. If glass plates are to be used, a full stock, six, or a dozen, of these should be added, for their weight is far from negligible.

The Camera.—Having regard to the circumstances enumerated, the apparatus that may be considered the most suitable is an entirely self-contained camera of the folding kind, arranged to take spools of rolled films. A folding pocket Kodak for quarter-plate pictures that we ourselves use is but little over an inch and a half in thickness, and a very substantial leather case provided for it is under two inches in thickness. Such a package is no burden, and is absolutely self-contained. There are other similar cameras to be obtained, and if the thickness may be increased a little, folding cameras of greater scope and of more general applicability, though probably not more useful on such a visit as this, are available.

The Lens.—By paying three or four pounds more, a first-class lens may be substituted for the ordinary one. This, of course, would be an advantage, but in the present instance so small a one that we do not recommend it, except for those who know that the work they mean to do will be benefited by it. The gain in using a costly lens is a better definition at the margins of the picture, with the possibility, therefore, of using a larger diaphragm and consequently giving a shorter exposure. But under the ordinary conditions that may be expected, the diaphragm of the cheaper lens may be small enough to secure good definition at the same time that the exposure is as short as is likely to be desirable.

Other Apparatus.—As to a tripod, if one be taken it should be a light one. Some metal stands are perfect in every way, compact and light, but the sliding parts of the legs if bruised are likely to become fixed or irreparably damaged, therefore a wooden one is preferable. But if a tripod is taken it will probably not be used, for experience shows that on such occasions a stand is so seldom wanted that it is not habitually carried with the camera, and that when the need for it does arise, it is not at hand. It may also be noted that it takes much longer to mount a camera on a tripod than to use it in the hand, and that when accompanying a party there is often no opportunity to take things leisurely.

It is a distinct advantage to have an "everset" shutter, because the "setting" of the shutter that is otherwise necessary is the one operation most likely to be forgotten. The only apparatus that it is desirable to carry besides what the word "camera" in its inclusive sense signifies, is an exposure meter or actinometer for use as described below. There are several kinds of these, some as small as a locket, the essential feature being that they contain sensitive paper that darkens on exposure, and gives an indication of the intensity of the light by noticing the time necessary to expose it for the production of a colour equal in depth to a standard tint.

Development.—In hot countries and trying climates it is not safe to keep exposed films long between exposure and development. It is possible to send them or bring them home for treatment at leisure, but it must be remembered that sensitive material is much more liable to injury from adverse climatic influences after than before exposure, and that any delay incurs risk and is practically certain to cause deterioration. The best method is to develop as soon after exposure as possible, that is, within a day or two, and here it is that the

use of rollable films presents an advantage that can scarcely be overrated. By means of a "developing machine" a whole roll of a dozen exposures can be developed at once, without any need for a dark room or its equivalent, and with a very much greater certainty of a good proportion of successful negatives than can be claimed for any other method. As a recent experience of what may be expected from such a manner of work, it may be mentioned that a friend of the writer, who does not claim to be even an amateur photographer, made a few months ago about three hundred and fifty exposures in and near the Soudan, and of these he has lost only ten or a dozen, which were spoilt by faults in using the camera, such as forgetting to wind up a new film after exposure. All the rest are useful, and a very large proportion technically perfect, without stains or faults. In using the machine—which is only a tank to hold the developer, and an arrangement for winding the length of film into a convenient roll for treatment—the best way is to take the developing powders that the makers provide in suitable small packets, and to follow the instructions as to time, &c., that are given with the apparatus.

Packing, &c.—The packing of the stock of sensitive films may well be left to the makers, for their considerable experience in sending such material abroad may be relied on; but it should be seen that they clearly understand where the material is to be taken to. It is usual to put each spool of film into a tin box, and if the lid is made secure by means of adhesive plaster instead of being soldered down, the tins can be used more than once—or for re-packing.

Rehearsal and General Procedure.—Before starting, a few exposures should be made and developed by way of rehearsal. A spool of six films, and, if necessary, a second similar one, will serve well for this purpose. With the shutter set at the twenty-fifth of a second, and the lens diaphragm at f/11, f/16, and f/22 respectively for each of three exposures on a suitable subject in good light, a sufficient idea will be obtained as to the conditions necessary. The exposure meter should be used at the same time, noting the number of seconds required to produce the standard tint. To adjust a subsequent exposure to an alteration in the value of the light, as shown by the different time necessary to produce the standard tint in the exposure meter, it is better to vary the lens aperture, for this change can be relied on, each aperture giving double the exposure of the next smaller. The shutter speeds are generally not exactly as marked, and it is possible that by pushing the pointer to the figure that indicates half the exposure just given, there may be no alteration in the duration of the exposure. With constant fine weather, it may not be necessary to test the light perhaps for days together, but if the weather changes, or the subject is unduly shaded, as it may be in towns or under trees, then the exposure meter should be used. If a longer exposure becomes necessary than the one suggested, the camera should be supported on or against some steady object, such as a wall, a gate, or a tree. Then, unless the times of the other settings of the shutter have been experimentally determined, it will be best to set the shutter index to "B" or "bulb," when the shutter will remain open as long as the bulb is pressed, and will shut as soon as it is released. Exposures of a quarter of a second and upward can be easily given in this way after a little practice.

The Great Zimbabwe, Rhodesia.

Among the scientific matters which will be considered by the British Association in the course of its visit to South Africa is the question of the origin of the ancient ruins which are scattered so profusely over the whole of Southern Rhodesia—an area extending some six hundred miles from east to west, and five hundred miles from north to south.

This territory, situated far inland from the shores of the Indian Ocean, appears to have some connection with the ancient history of the Near East, a conclusion resulting from explorations among these ruins which have been carried on during recent years. It is a conclusion which is intensely fascinating, not only to the archæologist and antiquarian, but to the Biblical student, for here are to be found the remains of an enormous gold-mining industry and the traces of an ancient civilisation, for which Semitic people, most probably from Southern Arabia, are responsible.

The age of the oldest type of ruined buildings is now believed to date back contemporaneously with, if not earlier than, the Solomonic gold period of Holy Writ, though much later waves of Semitic colonists have undoubtedly carried on in this territory the enterprise of their ancestors. It also appears that the most ancient type of buildings in Rhodesia yields evidence of Phallic religion, and of the worship of Baal and Ashtaroth as described in the Old Testament.

The main objective of these successions of colonists was that of gold-winning, for the remains of thousands of gold workings occupy the area in which the ruins are found. So extensive are these gold mines that experts believe that gold to the modern value of at least seventy-five million pounds sterling has been extracted in ancient times from the reefs of this country.

From the recently-published work* written by Mr. R. N. Hall, F.R.G.S., who spent over two years in exploring the central group of ruins, we gather that the structures are of various ages covering periods extending from the most remote antiquity down to mediæval times.

These buildings, which are admitted to be the greatest archæological wonder of the Southern Hemisphere, are in groups, but the groups are connected with each other, and also with the coast at the ancient port of Sofala, by chains of massive forts at a distance of a few miles from each other, and these forts occupy strategic points protecting well-defined routes of the ancients throughout the country. Messrs. Hall and Neal state† that there are at least some three or four hundred ruins or sets of ruins throughout the region of Southern Zambesia, and descriptions of many of these buildings and of the associated gold workings, together with information as to the ancient architecture, are set forth in detail.

The most important group of buildings is that of the Great Zimbabwe, *i.e.*, "the great buildings of stones." This is situated some two hundred miles inland west of the shore of the Indian Ocean at Sofala. Zimbabwe, both by the size of its buildings, the area covered (one and a half miles by one and a quarter miles), by its position, appears to have been the chief metropolitan centre of the ancient gold miners, and is undoubtedly

* "*Great Zimbabwe*" (Methuen)

† "*The Ancient Ruins of Rhodesia*" (Methuen)

among the oldest type of building to be found in the country. This group was re-discovered in 1868 by Adam Renders, an elephant hunter. In 1891 Mr. Theodore Bent visited the place and described it in his "Ruined Cities of Mashonaland." But in the days when Mr. Bent visited Zimbabwe, the whole of the ruins were in a buried condition, yet so far as he was able to describe these structures his account is perfectly reliable and of permanent value for the antiquarian.

During 1902-4 the Government of Rhodesia engaged Mr. Hall to explore this group of ruins and to take measures to secure their preservation. The interiors had, in the course of long centuries, become filled in with silted soil, the *débris* of later occupiers, and fallen walls, as well as rank sub-tropical vegetation. This gradual filling-up process had led to the burial of the ancient floors to a depth varying from six to twelve feet. With the aid of a gang of native labourers the work of clearing the interiors of some of the important portions of the buildings was taken in hand, but the operations, though carried on for over two years, revealed only a portion of the ruined structures comprised within the limits of the "Dead City."

Enough, however, was disclosed to prove beyond question the past existence of Phallic. litholations, and solar worship of a very old cult practised by the original occupiers. Not only were entirely fresh features of ancient architecture discovered, but such of the original floors as were uncovered yielded priceless relics of prehistoric times, including gold ornaments and religious emblems in rich profusion. When it is stated that thousands of feet in length of narrow and labyrinthine passages which had become lost to sight were discovered and cleared of *débris*, one can understand to what extent the ruins had in the course of ages been covered over. But the area occupied by this group is so extensive, and the distinct ruins are so numerous, that these operations, carried on under great difficulty and necessitating the constant exercise of care and patience during the exploration, still leave the great bulk of the Zimbabwe ruins buried and unexamined. It is quite possible that the buildings contain many more secrets of an important character to be unravelled by the archæologist.

The ruins of the Great Zimbabwe consist of three main sets of structures—(1), the Elliptical Temple with the conical tower; (2), the Acropolis or Hill Ruins of bewildering extent on Zimbabwe Hill; and (3), the Valley of Ruins, these latter being a conglomeration of smaller ruins of all ages occupying a large area in the Zimbabwe Valley.

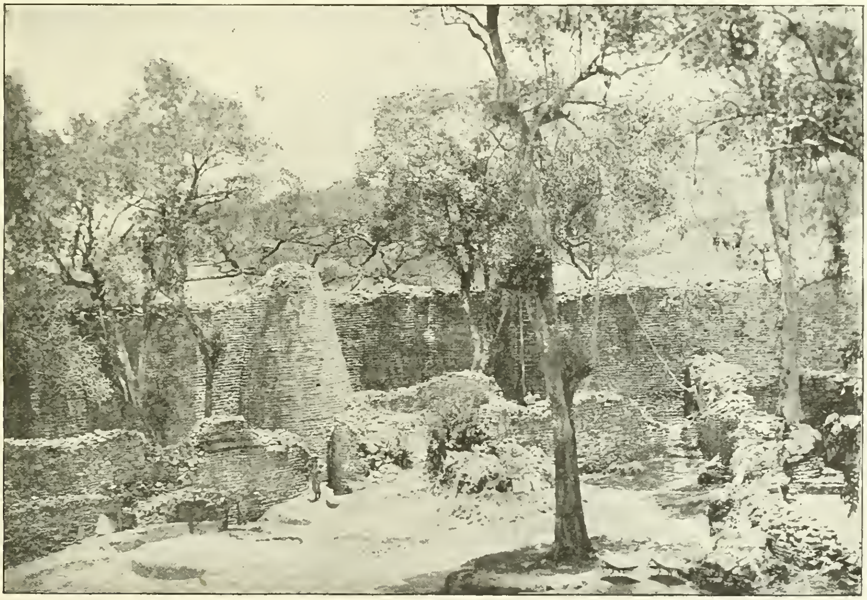


Fig. 1.—Interior of Elliptical Temple, looking East, showing Conical Tower.—Great Zimbabwe.

The chief archæological interest, however, centres in the Elliptical Temple (Fig. 1), an object arousing wonder and even sheer amazement to all who visit these ruins. Its massive and stupendous walls, gracefully sweeping curves, and most excellent workmanship and decorative mural patterns, at once rivet the attention. The plan of the building is elliptical, while the ends of the walls, sides of entrances, and buttresses are all rounded. The angular form of building is absent. The walls are very substantially built of dressed granite blocks laid without mortar or cement, and have bases averaging from 7 ft. to 16 ft. in width, and are beautifully and skilfully constructed not only on their exterior faces, but in their internal portions. The walls average a height of from 24 ft. to 31 ft., the main east wall being 16 ft. wide at its base, but at a height of 30 ft. its summit is 8 ft. in width. The lean-back or batter-back of the faces of the wall gives an

Eastern appearance to the building, which is very striking. The summit of the main east wall was once decorated with tall granite monoliths, the bases of some twenty-six monoliths still remaining *in situ*. The outer face of the east wall bears a pattern of chevron in two rows worked in granite blocks (Fig. 2). This pattern is one of the earliest decorative designs known to research, and is the ancient emblem of Water and Fertility of the old Nature worshippers.

The Conical Tower, 32 ft. in height, is one of the principal architectural features of this building. Its lines are worked out with marvellous skill. It is perfectly solid, and with it is associated a high stone platform approached by steps. The tower is considered by

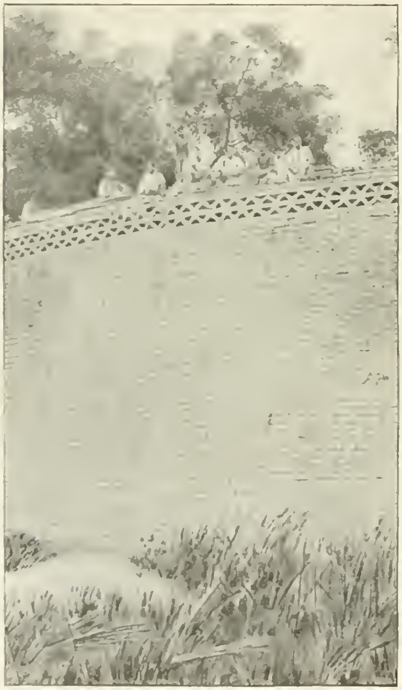


Fig. 2.—Chevron Pattern on Eastern Wall, Elliptical Temple, Great Zimbabwe.

many leading men of science to be identical in purpose, if not in general form, with the Baal towers of Arabia, Phœnicia, Canaan, and Babylon, referred to in Holy Writ.

The interior of this immense building is divided into some fifteen enclosures, and there is no less than 700 ft. length of passages within the walls, the most famous being the Parallel Passage, which leads directly from the north or main entrance into the Sacred Enclosure in which stands the Conical Tower. Many leading European experts place the age of the Temple at some period between 1600 and 1100 B.C.

There is great similarity between the architecture of Zimbabwe and that of several ancient temples in South Arabia. The Temple at Zimbabwe is admitted to be the finest example of an ancient Nature worshipping shrine known to the world. No inscriptions have been found at Zimbabwe, the earliest inscriptions found in any Phœnician Temple being not older than 700 B.C.

At Zimbabwe there are evidences of an ancient civilisation and arts whose only parallel in many respects, especially in their associations, is to be found in the ancient kingdoms of South Arabia. According to the Scriptures, and ancient Roman and Grecian historians, the Sabæans of South Arabia were the gold purveyors of the then known world. Rhodesia contains the most ancient and most extensive gold mines yet discovered.

The Gold Mines and Gold Production.

THE history of Africa as a gold producer dates back to very early times. It was not, however, till comparatively recently that South Africa, as now known, was found to be a gold-bearing country. In 1882 the De Kaap goldfields were started, while it was three years later before the famous Sheba mine was discovered and the town of Barberton founded. The existence of gold, however, had long been surmised, and was actually discovered in 1868, Carl Mauch referring to it as occurring near the Oliphants River. In 1870 it was found in the Murchison Range, and the next discovery was in the Lydenburg district, at Pilgrim's Rest. In 1884 Struben Brothers started a 5-stamp battery on the farm Weltevreden, in the western district of the Transvaal, for quartz mining, which is very dissimilar to "banket," as the huge conglomerate bed of the Witwatersrand basin has come to be known. The deposits consist of quartz pebbles held together by a siliceous cement containing iron pyrites. The gold exists in the finest particles, showing sharp crystalline structure on examination by the microscope, as against the rounded forms, through attrition, in alluvial deposits. Gold was first panned from the "banket" beds of the Witwatersrand (or white waters ridge) in 1885, and in 1886 Johannesburg, the "Golden City," sprang into existence, as if from the wand of a fairy. The goldfield is situated on a plain about 6,000 feet above the sea-level, across which the northern outcrop of the gold basin rises slightly, and roughly represents the watershed between the Atlantic and Indian Oceans. The formation has been traced practically continuously for about 60 miles along the strike of the Main Reef, from Randfontein in the west to Holfontein in the east. A length of about 12 miles of this, with the Langlaagte Block B on the west and Knights on the east, is described as the "Central Rand," the companies operating which are stated to be responsible for about three-fourths of the gold won down to the outbreak of war in 1899. But the conglomerate beds have been traced over far greater areas, outcrops and borings having revealed continuity for 164 miles, while nearly 150 miles are estimated to be concealed by recent measures and short interruptions by faults or dykes. Judging from the dip of the formation at the central northern outcrop of the basin, it was for some time supposed that the depth would become prohibitive for mining at a distance (say) of two miles. Enormous engineering feats will apparently not have to be undertaken, as exploration has shown

that the curve between the north and presumed south outcrops is not symmetrical. In fact, the bed of the area has a more or less level bottom, being a series of synclines and anticlines.

Gold mining is everywhere a highly speculative undertaking, but in the Transvaal great reliance can be placed upon the regularity of the ore deposits. This justifies very heavy preparatory outlays. It is, for instance, estimated that before an ordinary deep-level mine can reach the producing stage the expenditure on boring, sinking (say) two shafts, the erection of a mill of 400 to 600 stamp capacity, the connecting of the two shafts, and driving on the reefs to expose a sufficient quantity of ore to keep the mill in operation amounts to something like one million sterling. This, of course, refers to a proposition where the reef lies at a depth of about 3,000 feet, while the area of such a mine would be something like 1,000 claims. When the ore is "brought to grass," as it is termed, a series of scientific processes is brought into play in order to extract the precious metal. The most approved mechanical appliances and chemical methods are drawn upon, and the leaders of the industry are ever on the look-out for improvements, as the nearer perfection is attained—that is, 100 per cent. extraction—the more profitable is the result. The various processes are complicated and delicate in the extreme, and as each particle of gold is mixed with, perhaps, 60,000 particles of rubbish, as the Transvaal tonnage averaged in 1903, it can easily be conceived that the slightest miscarriage would be disastrous.

A great deal of attention has been given within the past 12 months to tube, or flint, mills. Such a mill at the Glen Deep consists of an iron cylinder, 22 feet long and 5 feet in diameter, with hollow trunnions at each end, through which the pulp to be ground passes in at one end and out at the other. The trunnions rest on solid bearings and the cylinder is revolved by a pulley at a speed of 38 revolutions per minute. The cylinder is lined with chilled steel, and inside seven tons of the hardest flint pebbles are placed. The pebbles are about the size of a tennis ball, and the rounder the pebbles the better. One such mill can deal with the coarse product from 20 stamps crushing 10 tons per diem each. It is estimated that the tube mill will enable the mill capacity to be doubled at the cost of £2,000 per 20 stamps, or £10,000 to £12,000 per 100 stamps, plus the extra cyanide plant and the cost of something less than 40 h.p. per 20 stamps. Many of the leading groups are now erecting these secondary crushers.

The high altitude of the Rand has rendered the question of water supply of first importance. The mines relied upon reservoirs for the collection of a sufficient supply during the rainy period to carry on mills and cyanide works throughout the dry season, the Johannesburg Water Works doing its best to meet the frequent deficiencies. But the Transvaal Government appointed an investigating Commission in 1901, and in May, 1903, a Water Board was established. The undertakings proposed to be acquired were the Johannesburg Water Works, the Vierfontein, Braamfontein, and Wonderfontein Syndicates. The last-named was, however, omitted, as it was thought that otherwise the irrigation of the Potchefstroom District might suffer. The Rand Water Board issued £3,400,000 4 per cent. inscribed stock in March last. The Board supplies towns in bulk. The mines are supplied through mains laid along the Rand by the Board at the rate of 3s. 6d. per 1,000 gallons, and 3d. less where not less than 300,000 gallons per day are consumed. The rate is not cheap for mines, but when it gets much beyond its present daily consumption of two million gallons, a reduction will be possible. The mines, of course, will not draw upon it until their private reserves in dams, &c., are exhausted. The advantage is that no stopping of mills need be feared now, for it is estimated that about 10 million gallons per diem can be obtained from the undertakings acquired.

From the above survey of the Transvaal gold mining industry its magnitude may be gathered and an idea obtained of one of the most exact industrial organizations of the world.

South Africa as a Health Resort.

Those who have visited South Africa, and made any prolonged stay there, can hardly fail to be sensibly impressed with its possibilities as a health resort.

Medical men when ordering a "change," recognise that the human constitution requires—above all things—to be subjected to the effects of *contrast*. In recommending the South African continent, this desirable end is achieved in the contrasts afforded by a voyage to a distant land, by climate, scenery, and inhabitants; a series, making for a cumulative restorative effect.

Climates are classified as follows:—(1), Climates of the sea-shore; (2), Mountain climates; (3), Desert climates; (4), Ocean climates. South Africa itself partakes of the first three; and the invigorating influences of the last-named may be enjoyed on the voyage thither.

(*a*) The climate of the sea-shore of South Africa is best experienced during the winter months, commencing in April and ending in September; during these months (in Natal) the season is dry. The climate is warm, temperate, sub-tropical, sometimes cold; the warmth, often of a humid nature, and for that reason is, in consequence, more enervating than the South African continental climates; yet it has its ozonic-tonic properties. The health seeker will derive great benefit from a stay at Durban, Port Elizabeth, or even Cape Town, and at the same time be able to indulge in easy journeys into the interior of the country, where the air is more rarefied by reason of the higher altitude. The best hotels are expensive, but the interests of visitors are well cared for.

(*b*) The term "mountain climate" applies to all elevations between 3,000 and 6,000 feet. Ranging between these heights are the steppes of Natal, extending in a series of gradually rising terraces from the sea, and ending in the majestic peaks of the Drakensberg Mountains, the high veld of the Transvaal, extending to the Magaliesberg Mountains, and the higher tableland, having the township of Middelberg as a centre, and terminating in the north at the mountains round Lydenburg. Nestling at the feet of these mountains, and scattered about the kopje-dotted veld, are the homes of the Boer farmers. The mountain peaks reach as high as 12,000 feet. The climate of the steppes, high veld, and tableland, is never at any season too warm, when living in houses, and is generally dry during the winter months. In winter-time the

air is crisp, clear and invigorating, and the power of the sun pleasant. The nights are cold, as many as 20 degrees of frost having been recorded. In summer at no time is it insufferably hot. Persons afflicted with an hereditary tendency to consumption, or those suffering from overwork in business, will find these "mountain climates" promise a return to health. The therapeutic elements of a good climate are these, viz., abundance of sunshine without excessive heat, allowing of an open-air life all the year round, pure air, and a temperature adapted to the requirements of the invalid. To these essentials may be added the inestimable boon of necessarily conforming to and living the "simple life."

(c) If the characteristic essentials of a desert climate are advocated, consisting of warmth, dryness, purity of air, and large radiation, these are found in the expanses of the Kalahari Desert and Great Karoo. Probably no country is to be found where an outdoor life is so practicable winter and summer as in South Africa, and in which the traveller will find greater variation of or more majestic scenery. The seeker after health, who owns a fair amount of muscular power and activity, will find a long trek in a well-provisioned ox-waggon, say, through Natal to the Transvaal, a sure guide to the restoration of full mental and bodily vigour. The features of the scenery encountered are among the most sublime in Nature, while strikingly distinct from that of other lands.

NOTES.

Gold-mining and Labour.

WHEN the South African war broke out (October, 1899), 6240 stamps were providing employment for over 110,000 natives, and gold was being produced at the rate of £20,000,000 per annum. Three companies restarted milling in May, 1901; but at the end of 1903 only 64,000 "boys" were at work on the Witwatersrand, and only 4360 stamps were crushing, out of a total of 7145 erected. The latter were capable of employing 142,000 "boys" under the best economic conditions, while 30,000 more were required for mines merely in the development stage. There was, however, a proved deficiency of 108,000 natives, and moreover it was estimated that within the next five years a total of 11,000 stamps additional to those then existing might be erected. The Labour Importation Ordinance came into force May 19, 1904, and the first shipment of Chinese as mine-workers arrived at the New Comet Mine at the end of June, 1904. From the details supplied by members of the Transvaal Chamber of Mines and other companies it was shown that unskilled native labourers in employment at the end of 1904 numbered 77,014, and Chinese coolies (indentured) 20,396. These, with about 2000 Cape "boys" and Indians, made up a total of 99,623. The numbers at work on the 31st of May last were: Natives, 96,226; and Chinese, 40,117. At the end of December, 1904, the skilled and unskilled white labourers at work on the surface or in the mines numbered 14,173, and the wages bill came to £4,337,256. At the beginning of June, 1905, the number so employed was 16,626. On the Rand alone 5555 stamps were in operation at the end of December, 1904, and during the whole year 8,058,296 tons were crushed, the yield from the mills, cyanide and other reduction works being 3,658,241 ozs. of fine gold, of a total value of £15,529,219, or 38·46 shillings per ton crushed. In April, 1905, 6665 stamps were in operation in the whole of the Transvaal, and a tonnage of 929,268 was milled for a yield of £1,695,550, as against a monthly average of £1,337,900 in 1904. The total production in the Transvaal to the end of May amounted to £132,765,870; for 1904 the total was £16,054,809, or more than one-fifth of the world's production during the year, estimated at £71,898,713.

Big Game Extermination.

THE greater part of the country which will be visited by the members of the British Association possesses special interest for the naturalist from the circumstance that it was once the home of a multitude of big game animals, the like of which was unknown in any other part of the world's regions within the historic period. Their numbers, however, have been decimated through the avarice or improvidence of civilized man, aided in some measure by the native races, following their acquirement of and subsequent familiarity with the use of fire-arms. Within modern times the tract of country in South-East Africa where these big game animals abounded most was probably the plains of Bechuanaland, the Orange River, and the Transvaal, parts of which formed the hunting-ground of Gordon-Cumming and other pioneer sportsmen, but earlier the plains of Cape Colony were populated by a vast fauna of large and beautiful game animals. At the commencement of the Dutch occupation we read of white rhinoceroses being met with quite close to Cape Town. The Dutch, however, were not long in perceptibly decreasing the number of big game in the country; and one beautiful species of antelope, the bluebuck, or blaauwbok, seems to have been exterminated at a very early date. But some excuse for the vigorous efforts of these Dutch pioneers to thin out the animals which occurred in such swarms in the newly-colonised country may be found, for about the middle of the 17th century we read of their gardens being raided by elands and kudus, and their larger crops destroyed by the incursions of rhinoceroses and hippopotamuses; while on one occasion a slender garrison was actually in fear of the fort being stormed by a frontal attack of lions. Gradually the game was driven further and further up country, though a sufficient percentage remained for the sportsman and naturalist. It was not till after 1837 (twenty-two years prior to this the explorer Burchell had crossed the Orange River and entered Bechuanaland) that the Boers trekked to the districts now known as the Orange River Colony and the Transvaal, and, once there, the fierce pursuit of the game, which, as we have seen, had taken place in Cape Colony, was repeated, but at a more rapid rate, owing to improvements in fire-arms, and the operations of the "skin-hunters," who shot down the animals by tens of thousands, prompted by the commercial uses to which their hides could be put. Between the years 1840 and 1875 the destruction of animals in the old republics, it is safe to say, might be reckoned by millions. According to report, in the year 1860 one specially notable "drive" was instituted, and for this occasion some 25,000 head of game were enclosed, of which it was computed that upwards of 6000 were slaughtered. The settlers realised the market value of the herds of big game with which the veld of the Orange River Colony and the Transvaal was at that time swarming, and took full advantage of their opportunities. By about 1880 a clean sweep of the game had been made, and to-day one may wander over those same plains which, in Gordon-Cumming's time, were actually blackened by the presence of roaming animals, without seeing even a single herd of game, or, at most, nothing more than a few springbok as survivors. Nor was the destruction confined to skin-hunting; ivory was an even more valuable commodity, and so keen has been the pursuit that there are now but few districts remaining where elephant-hunting for profit can any longer be regarded as practicable.

From Cape Colony to the Transvaal the effort is too late for effective game preservation, and all that can be done is to preserve the scattered herds of the surviving rarer species till such time as they perish from in-and-in-breeding. In Rhodesia and other neighbouring districts the outlook is more hopeful, and whatever is possible under existing circumstances is being done to ensure the preservation of a portion at least of the game. As colonisation and civilisation spread, the wild animals of the country will inevitably tend to disappear, and, however unwillingly, we must face a time when, notwithstanding international co-operation, a large portion of Africa will be as destitute of big game as are the more frequented districts of Cape Colony and the Transvaal at the present day.

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By WILLIAM J. S. LOCKYER, M.A., PH.D., F.R.A.S.

I.

SOME time ago an account was given in these pages (Vol. I., p 150), of some of the results which Prof. Hale had secured with the spectroheliograph he had so successfully designed and used in conjunction with the great refractor of the Yerkes Observatory.

This work, as I have pointed out elsewhere, marked a new epoch in solar physics, for it suggested possible fields for research which, up to that time, were not considered within the region of practical accomplishment. Thus, for instance, it is now possible to determine the distribution on the sun's disc and limb of such substances as calcium, hydrogen, iron, and many other materials, the lines in the spectrum of which are sufficiently strong in the solar spectrum. Not only can this question of distribution be minutely studied, but by securing photographs in different years the variation of the areas covered by these substances from year to year can be measured. In this way we have a method of estimating solar activity. Again, we are in the presence of a means of very considerably increasing our knowledge of sunspot formation because spots give us only a very brief span in the life history of a disturbed region, which can now be photographically traced long before any indication of a spot is detected and long after the spot itself has disappeared.

Further, a means is now afforded of rapidly securing the forms and positions of prominences on the solar disc at one exposure, either by using calcium, hydrogen, or, possibly, other lines for the investigation. By successive exposures on any particular portion of the limb comparatively rapid changes in prominences can also be photographically recorded.

These and many others are some among the numerous problems that are now waiting investigation by the aid of this powerful instrument of research, so that there is plenty of work for those students of Solar Physics who wish to participate in this field of inquiry.

At the present time there are not many of these instruments at work, or even in existence. In addition to those used by Prof. Hale in America, and M. Deslandres at Meudon, in France, Mr. Evershed, in England, has been securing some small scale pictures during the last few years; while at Potsdam another small instrument is mounted on an equatorial telescope. At the Solar Physics Observatory, South Kensington, a somewhat larger instrument than the last two mentioned has been at work during the past year, and nearly a duplicate of this has been despatched to India and is now in working order at the Kodiakanal Solar Physics Observatory.

There is every reason, then, to hope that before long more instruments will soon be erected and set in operation in order to assist in the accumulation of material for increasing our knowledge of the physics of the sun.

Fig. 1.—The 12-inch Taylor Photo-visual Lens and Support for forming the Solar Image on the Primary Slit of the Spectroheliograph.

In the following paragraphs it is proposed to briefly describe the South Kensington instrument and to refer at no great length to some of the results that have been gleaned from the photographs that were secured during the summer months of last year. A more complete account will be found in the Monthly Notices of the Royal Astronomical Society (Vol. lxv., p. 473), in a paper communicated by me during last March.

Unlike the spectroheliographs employed at the Yerkes and Potsdam Observatories, where both are worked in conjunction with equatorial telescopes, the one at South Kensington is so arranged that the solar image is formed by a lens (Fig. 1), on which sunlight is thrown

by means of a siderostat. In fact, the complete instrument consists of a siderostat to constantly throw the solar rays horizontally in a due south direction, a lens to form the image of the sun, and the spectroheliograph to obtain monochromatic pictures of this image.

The siderostat (Fig. 2) has a mirror of 18 inches diameter, and the lens an aperture of 12 inches, with a focal length of 18 feet. The solar image thus formed has a diameter of 2 1-7th inches, which is the same size as that of the monochromatic image photographed.

To secure the latter the optical arrangement is as follows:—The stationary solar image falls on a slit plate with jaws, 3 inches long, mounted at the north end of a tube, while at the other end of this tube is a lens 4 inches aperture and 6 feet focal length; this forms the collimater. The light, after traversing this collimater, then impinges on a plane vertical mirror and is reflected on to a prism. This prism is so placed that the light, after passing through it, falls on to another 4-inch object glass of 6 feet focal length, mounted at one end of another tube similar and parallel to the collimater. In the focal plane of this objective, in which a spectrum is formed, a second slit with jaws $3\frac{1}{2}$ inches long is placed in position. By so adjusting this secondary slit any particular line in the spectrum can be made to pass through the jaws by itself. In this way a line in the spectrum of calcium, or hydrogen, or iron, &c., can be isolated. The lines of the spectrum formed in the above manner are not straight but curved, so that it becomes necessary to employ a slit, the jaws of which are curved to the same amount. Such a slit requires,

Fig. 2.—General View of the Large Siderostat showing the 18-inch Plane Mirror. The upper portion of the House is here moved on its rails towards the north.

in consequence, very careful adjustment, and the means adopted for placing the jaws in any required position can be well seen in the accompanying figure (Fig. 3).

By means, then, of the above optical arrangement, any particular strip of the sun's image which passes through the jaws of the first or primary slit issues through the secondary slit as light of one wave-length or colour.

If the whole spectroheliograph be gradually moved across the solar image different strips would enter the

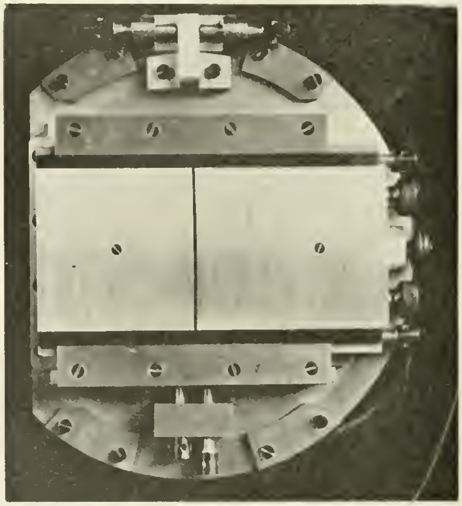


Fig. 3.—The "Secondary" Slit, showing the various Screw-adjustments available for setting the curved jaws exactly on the "K" line.

primary slit, and they would build up a picture of the sun in one wave-length at the second slit.

In order to produce this change of position in relation to the fixed solar image, the slits and optical parts are mounted bodily on a movable platform. This platform (see Plate 1, Fig. 1) rests on three balls, each of which is capable of movement between steel surfaces, the lower ones being fixed to the upper surface of another triangular framework supported by three concrete columns. To ensure *uniform* motion—a very important consideration—the movement, which is produced by falling weights, is controlled by the flow of oil through an aperture, the size of which can be varied at will. The direction of the motion required, namely, that in a horizontal direction and at right angles to the axis of the solar beam falling on the primary slit, is obtained by pressure of the upper platform against a guide bar fixed on the lower framework in the correct direction. The photographic plate, like the solar image on the primary slit, must be fixed relatively to the spectroheliograph. This is accomplished by placing firmly on the concrete column a vertical mahogany slide into which the plate holder can be placed as close up to the secondary slit as possible without actually touching any portion of it.

The method of procedure adopted to secure a disc picture with this apparatus is as follows:—

The adjustment of the secondary slit to isolate the centre of the "K" line being made, this slit is closed to the required width. The primary slit is next placed in the meridian and the solar image brought by the slow motions central on the slit. This image is then carefully adjusted for focus. The shutter behind the primary slit is then closed.

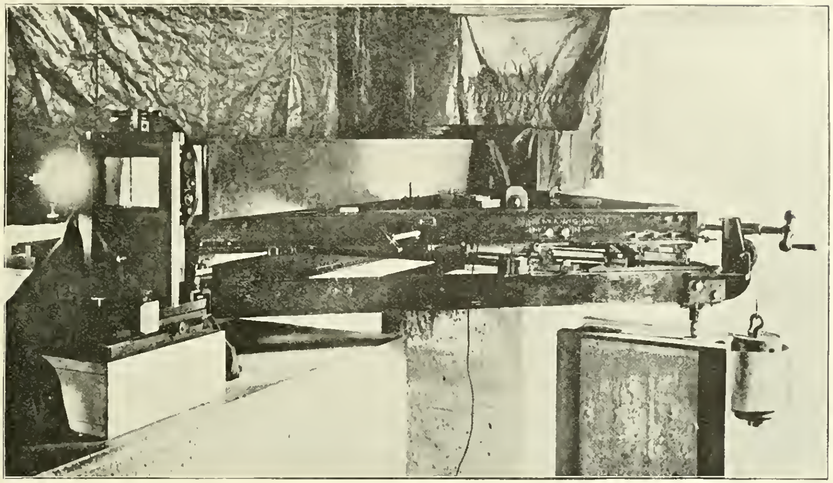
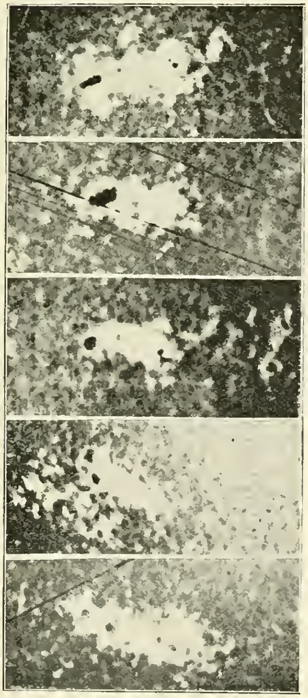


PLATE I. Fig. 1.



1904.

April 27th.

April 27th.

July 14th.

August 2nd.

August 29th.

West. Fig. 3. East.

1904.

May 23rd.

August 2nd.

Sept. 26th.

Sept. 26th.

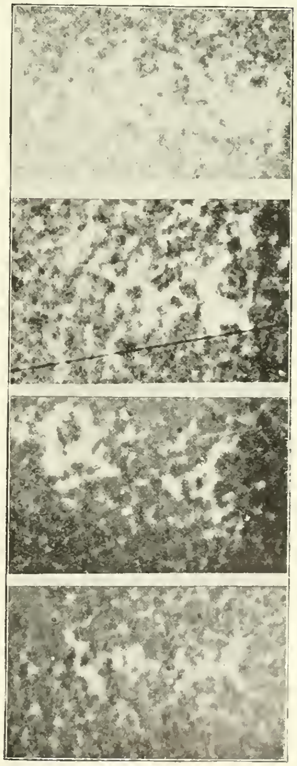


Fig. 2.

(*To be continued in our next issue.*)

The Nature of Life.

By Geoffrey Martin, B.Sc. (Lond.).

III.—The Possible Significance of Alcohol Drinking.

When a child I lived in a small town in South Wales. In the town the people spoke only English; in the remoter country districts the peasants still spoke Welsh.

The language that these peasants spoke had for me at that time no interest or significance.

It was a rude, imperfect dialect which was only spoken by uneducated people.

To me now, in after years, how different appears that rude peasant dialect! It signifies for me now the relics of a by-gone time when this poor dialect was a great world speech—such as English is now—and these rude peasants the representatives of a mighty people—the Kelts—whose armies swept in waves of living valour from out of Asia into lands so distant as Ireland, Spain, and Asia Minor.

Now what has worked the difference in my mental attitude? Solely increase of knowledge. When a child I knew nothing of the Kelts nor of their history. And so it is generally. A treatise on Bessel functions has no earthly interest for a Matabele warrior; the mathematical physicist is deeply interested in such a book; the interest of the mathematician is the result of a knowledge of the use and possibilities of such functions. The uninterest of the Matabele is due to his ignorance.

Many matters appear to possess no interest or importance to us simply because of our ignorance. Suitably viewed such facts become pregnant with world-wide consequences; for example, the blind hates and bitternesses which exist between peoples of different races has possibly no particular significance for the average man, except perhaps as a deplorable fact. To a scientist these racial hates inspire the greatest interest, for in his eyes they are but the outward play of those mysterious organic forces which cause evolution and the differentiation of species.

The almost universal drinking of alcohol, and the vice of drunkenness, which exists among all peoples and in all times of which we have any record, is another phenomenon of the same kind.

We propose here to review this last matter as a scientific problem, and gravely consider the physiological reason why men of all animals have this natural instinct after strong drinks most strongly developed.

Is it the manifestation of some great and imperfectly understood organic tendency, or is it only of the nature of a disease?

We proceed to discuss this question solely from a chemical standpoint.

One condition which seems indispensable for the manifestation of vital activity is fluidity. All living matter is bathed in fluids and it itself has a mobile semifluid constitution; all facts point to the conclusion that the condition of fluidity is intimately connected with life; it is even said that life first originated in the fluid sea and thence spread to land.

Certainly the observation that by far the greatest part of living matter consists of water, either free or combined, lends strength to this supposition.

The reason of this mobile and semifluid condition of living matter becomes manifest when we begin to study its chemical nature. Living matter is a complex system of atoms in eternal breakdown. The very condition of life seems change. Only in a semifluid condition can take place that continual redistribution of matter which, while preserving the form of living matter intact, supplies that flux of atoms which counterbalances its continuous decomposition.

Where the external physical conditions as regards temperature and pressure are such as to render the existence of matter in a fluid or semifluid condition impossible, then life as we know it would be incapable of existing. For example, at very low temperatures, all matter solidifies and the fluid condition as a phase becomes impossible. Even the most volatile gases first condense to liquids and then change to solids, so that at a temperature approaching the absolute zero we look out upon a frozen solid world.

The constitution of living matter must therefore be so adjusted to the external physical conditions as regards temperature and pressure that it continually maintains this condition of fluidity. When we contemplate the history of the world we find that these conditions have in former times been widely different from those which at present hold. There was a time when the world was a white-hot sea, when the moon had not yet been flung off by some mighty catastrophe from the revolving glowing mass. As ages passed the world cooled and cooled, until finally the temperature conditions which now reign were attained.

But the process of cooling is not finished; the world is still cooling and there will surely come a time when the average temperature of the world will sink from its present value (15° C) to 0° C, to -10° C, -100° C, and finally below the freezing point of hydrogen itself.

Even at the present time the temperature of the world is only slightly above that temperature at which all the water on the earth will pass into the solid condition. Indeed the process of solidification has already commenced. Vast regions are found where the water has already permanently passed into the solid condition; and the regions will extend with time until the seas and the mighty oceans themselves will freeze and be converted from top to bottom to a vast mass of ice.

Water will appear to the inhabitants of future days as solid deposits of mineral matter, presenting to them much the same appearance as the white masses of marble rocks in certain parts of the world appear to us.

At first sight it would appear that the effect this universal solidification of water will have upon the life of the earth in the form we know it will be its absolute destruction. For with the passage of water into a solid state the existence of living matter in a fluid or semifluid condition becomes impossible.

Water is one of the most volatile and important constituents of living matter; all the tissues are bathed in watery fluids, and by far the greatest portion of living matter is actually composed out of water. Upon the fluidity of water hangs the mobility and fluidity of living matter as we know it.

It is true that the freezing point of water may be lowered even to a considerable extent by the addition of impurities to it. For example, a mixture of water and salt can remain fluid at temperatures very much

lower than that at which pure water freezes. Yet even this artificial lowering of the freezing point of water will only enable us to stave off for a time its universal solidification in the tissues and the consequent passage of living matter into a solid frozen condition.

Were living matter a rigid unadaptable machine, one might well look with despair upon the prospects of life in the coming ages of cold and eternal night. Many facts we know, however, point to the conclusion that living matter posseses the power of adapting itself to changing external conditions; for example, it is a well-known observation that by gradually raising the temperature of water in which certain organisms live, we can in the course of time cause them to live and flourish in water so hot that specimens of the same organism which had not become acclimatised to the changed temperature are at once killed when placed therein. The question is, therefore, in what direction can living matter change its constitution in order to adapt itself to temperatures much below that at which water enters into a solid condition?

One thing appears certain. If living matter is to avoid being frozen hard with the falling temperature, the water as such must be gradually eliminated from the organism and its place taken by another liquid which remains fluid and mobile under conditions which render the existence of water as a fluid impossible.

Now is there any other fluid which perhaps could take the place of water in living matter and fulfil this condition? Alcohol seems to be such a fluid; alcohol freezes at -130° C, water at 0° C.

Moreover, of all the known compounds alcohol is the one which approaches both chemically and physically nearest to water in properties.

Both are mobile fluids; both are great solvents; both have a very similar constitution—alcohol, in fact, is water in which a hydrogen atom is replaced by the heavier radicle C_2H_5, thus:—

$$\begin{matrix}H\\H\end{matrix}{>}O \qquad\qquad \begin{matrix}C^2H^5\\H\end{matrix}{>}O$$

water. alcohol.

Alcohol can perform many of the functions of water; for example, just as water can combine with molecules to form "Water of Crystallisation," so also alcohol can, and we can likewise speak of "Alcohol of Crystallisation."

Moreover alcohol is, like water, though to an enormously smaller extent, associated with living matter. It is the product of fermentation in enormous quantity by the lower forms of life, and occurs to a greater or less extent in fermented ripe plants and fruits.

It is, therefore, by no means inconceivable that alcohol could enter into the constitution of living matter to an enormously greater extent than it does at present, and thus replace the water as the fluid which bathes the tissues.

Moreover, there even seems to be at hand the mechanism by which such a replacement could be brought about; certain of the lower forms of life can manufacture alcohol as a product of their vital activity.

The whole phenomenon of alcoholic fermentation is an instance of this fabrication.

We have only to conceive that this fabrication of alcohol takes place to an increasing extent in the living body itself. These alcoholic ferments can be conceived to enter as the temperature falls to an increasing extent into the constitution of living matter, and thus to gradually increase the store of alcohol in the body itself. So that when the temperature falls below that at which water freezes, the watery fluids in the lower forms of life will have been replaced by fluids in which alcohol largely predominates, and which, therefore, remain fluid and mobile at a temperature whereat the plant would be frozen hard if it contained only water.

The age of water life would thus gradually pass into the age of alcohol life; and the cause of the variation would be the necessity for the organism to adapt itself to the altering external physical conditions by eliminating a less volatile for a more volatile fluid.

It is in the light of this conception that we approach the treatment of the question of alcohol drinking by the human race. It is well known that men in cold climates drink alcohol in a more concentrated form than the men of warmer lands.

Coldness, in fact, seems instinctively to drive men to alcohol. And if the temperature of the world is gradually reduced, so as to replace a temperate climate by a colder one, doubtless this tendency would be greatly intensified.

I can easily imagine a process by which man first began by drinking only water—as the lower animals do now; then by drinking water with a little alcohol in it, as man does now; then as the world grew colder and colder age by age, the amount of alcohol in the drink gradually increased until ages hence man will have evolved into a creature which will drink only alcohol. Together with the increase in the alcohol in the fluids man consumed, the quantity of alcohol in the fluids of the body increased, and the quantity of water diminished, until ultimately in the course of ages the constituents of the fluids of the tissues so altered that the water was entirely replaced by alcohol. The process of evolution would then be complete; a less volatile fluid would be replaced by a more volatile one, by a process probably of the same nature that caused the less volatile elements such as sulphur, phosphorus and silicon, to be replaced by the more volatile ones such as oxygen, nitrogen, carbon, and hydrogen.

Water would then exist in mere traces in the body, much as S does now, as the relics of a bygone time when it assumed a far greater importance in living matter than it does at the present time.

Is not this tendency men have to abstain from drinking pure water and to drink instead alcoholic beverages nothing else than the beginning of the gradual replacement of the water in the human body by alcohol?

Viewed in this light the phenomenon of alcoholism assumes the greatest interest and importance, as the possible manifestation of a mighty organic change sweeping slowly but irresistibly over the whole of living matter.

It may be, however, that some other fluid—for example, an oily liquid such as is found in great quantities in the bodies of fishes which live in cold seas—and not alcohol, would be the liquid which will ultimately replace water in living matter. Whether this be so or not, one thing, I think, is almost certain, and that is that if life is to continue at much lower temperatures than those which hold normally upon the earth, the water must be eliminated and its place taken by another liquid harder to freeze.

We beg to call the attention of regular readers to the new system of Subscription announced on page X.

The Induction Pump.

With Suggestions as to Reversal in Influence Machines.

By Charles E. Benham.

In two previous articles published in "Knowledge" (November, 1904, and May, 1905) some simple experiments in electric induction were described, the general principle of which was that of the original "doubler" of Abraham Bennet, and also to some extent that of the majority of devices which succeeded the doubler, with a view to render the multiplied-charge process available in a practical way. Such devices include the machines invented by Varley, Toepler, Voss, and others, as well as such modifications as Lord Kelvin's water dropping apparatus, and finally the admirable arrangement adopted by Mr. Wimshurst, and known by his name.

The multiplying process, by which these machines acquire such powerful electric charges, is briefly attributable to the fact that while an insulated charged body can confer, by induction, without losing its own electricity, successive charges of opposite sign upon two or more conductors successively earthed when near it, it can obviously be made to receive in return an increase of its own charge if it in turn is placed within the inductive sphere of those two or more charged bodies so that they all re-act upon it simultaneously. This is the principle that underlies the action of most of the influence machines, the difference being chiefly in the way in which this cycle of action and re-action is brought about.

It was shown in the experiments already referred to that there are alternative ways of carrying out the process. For instance, the simultaneous re-action of two or more inductively charged bodies may be provided for either by bringing them into actual contact

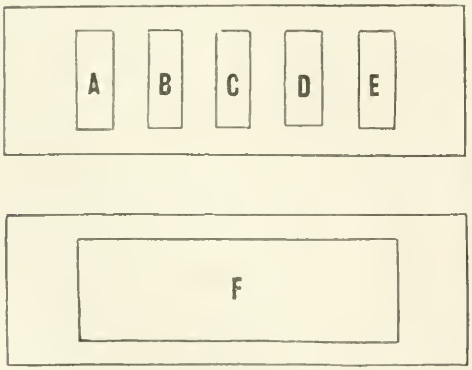


Fig. 1.

with each other by super-position, or by merely placing the conductor that has to receive their conjoint influence in an intermediate position so as to be within the sphere of all of them. The latter process lends itself more readily to practical application. For example, if a series of strips of tinfoil are attached to the under side of a piece of glass, as in Fig 1, A, B, C, D, E, they may each be given an induced charge by the single piece of insulated tinfoil F, on the upper side of a similar glass, if this plate is drawn successively over A, B, C, D, and E, earthing each as the front edge of F passes over it. Then, placing the plate bearing F over the other, and touching F, it receives from A, B, C, D, and E a combined influence, increasing its original charge. On repeating this cycle a few times the tinfoils, which had no measurable initial charge, become strongly electrified, the sign of F's electricity being the opposite of that of A, B, C, D, and E. Reducing the experiment to a still simpler form, the tinfoils A, B, C, D, and E may be dispensed with, and the finger may be placed on the under side of the plain glass instead, drawing it along as F is moved, so that it successively occupies the posi-

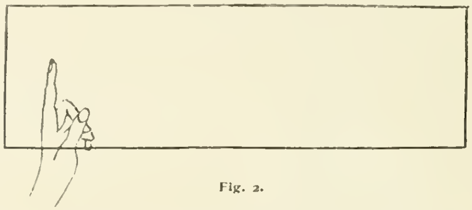


Fig. 2.

tions of A, B, C, D, and E (see Fig 2), and it will do duty for the tinfoils. The charge is retained by the glass surface, and after a few strokes from end to end, alternated with earthings of the upper tinfoil, the charges will accumulate. There is no need to move the upper plate at all during the charging process. Let it rest on the plain glass, and draw the outstretched finger lightly over the under surface of this several times, each time touching the upper tinfoil after the operation, and a considerable charge will accumulate on the upper plate and will be given off by its tinfoil when the two plates are parted and a conductor is presented to the upper one. That the charge is not due to friction from drawing the finger over the lower glass is evident from the fact that sometimes the charges will be positive and sometimes negative on the upper plate.

This variation of the polarity is very curious, and it is difficult to associate it with a definite cause. Two such pairs of induction plates may be made exactly alike, and kept near each other under precisely similar conditions. On testing their action at different times the upper plates of the two pairs will sometimes be found oppositely charged and sometimes similarly. A number of observations made at various times of the day, and under various atmospheric conditions, failed to show any agreement of behaviour on the part of the two pairs of plates. Sometimes they would retain the same polarity for several days. Sometimes one would change every few hours and the other would continue constant for a long while. At other times each would vary at very short intervals, and occasionally one would be so inconstant that it was difficult to make it acquire an accumulated charge. In 70 observations taken at various times of the day during the space of a week, the upper

plates of the two pairs of inductors gave the following results :—

First pair.	Second pair.
43 times negative.	53 times negative.
26 times positive.	17 times positive.
1 time variable.	

The induced charge of the upper plate was thus more frequently negative than positive in both cases. If the charge had been due to friction by drawing the finger along the under plate, that plate, being well coated with shellac, would have been charged negatively, and the induced electricity in the upper plate would have been positive, showing again that the charge could not have been initiated by friction.

As is well known, the Wimshurst machine, or any other self-exciting influence machine, is in the same way variable as to the polarity it will assume at starting after it has been left at rest for some time.

Returning now to the experiments described in the two former articles, the object of the present contribution is to explain how the same process (briefly recapitulated above) may be utilised more effectively for

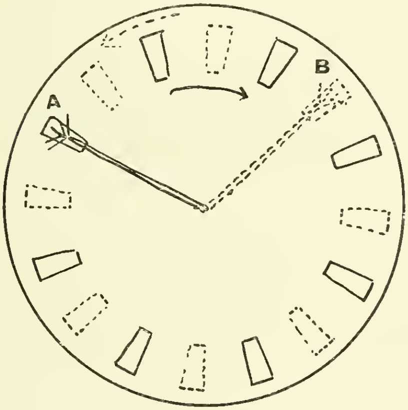


Fig. 3.

pumping up from the earth really practical supplies of electricity; how, in fact, a machine may be made on this principle, and incidentally how such a machine as the Wimshurst is a contrivance of this very character.

In the Wimshurst the disposition of the brushes and oppositely rotating discs gives, as was shown in the first article, a double multiplying arrangement of character similar to that which we have performed by hand more tediously in the experiments that have been described in this and the preceding articles. It follows, indeed, that two oppositely rotating discs, with sectors, as in the Wimshurst, ought, theoretically, to become charged with electricity of opposite sign with only a single brush to each disc placed as at A and B (Fig. 3).

A moment's consideration of this diagram will show that the directions of rotation of the respective discs being as shown by the arrows, the sectors successively charged by induction at the brush A will (two or three of them at least) re-act simultaneously on the other plate at B, when they have travelled to the position in front of that brush. Inversely the sectors charged successively at B will several of them act simultaneously upon the sector at A, when they have reached that spot. At A and B, therefore, there will be two points at which continually increasing induction charges of opposite sign will be received. It will be found, indeed, that, arranging the Wimshurst apparatus in this way, with only two brushes, theory is exactly borne out by experience. The brushes promptly glow, and the two discs are oppositely charged. It is this latter fact, however, that renders their charge unavailable under such conditions. The opposite charges of the two discs hold each other "bound," and consequently the collectors are not able to draw off any charge from the plates when arranged in this way with the two single brushes. The four brushes of the Wimshurst provide for opposite charges on different parts of each disc, with a consequence that at certain parts of the revolution (where the collecting combs are placed) the adjacent part of each disc is charged with electricity of the same sign, and this, of course, is not "bound," but is readily taken off by the collectors. It is in this way that the Wimshurst machine is so efficiently adapted to its purpose, the charges being "bound" at such portions of the revolution as is appropriate, and set free only at such portions as are necessary for collection of the charge.

It is, however, obvious that if it were possible to

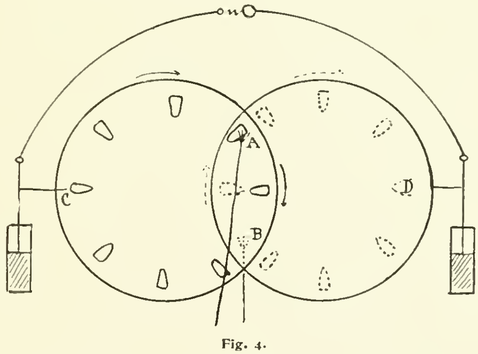


Fig. 4.

liberate the "bound" charges on the two discs arranged with the two single brushes as shown in Fig 3, we should have an efficient accumulator capable of charging jars, as in the case of the Wimshurst.

This liberation can be effected by providing that a portion of each disc shall be removed from its companion's influence. If, for example, the discs are placed as in Fig 4, the induction can still be effected by placing brushes at A and B, where the discs overlap, while the collecting can be accomplished at the free parts of the discs, viz., at C and D. It will be necessary, however, in order that the sectors may travel past each other in opposite directions, that the discs themselves should both rotate the same way, as shown by the arrows in the diagram.

This device is a true induction pump, drawing, in chain pump fashion, from the earth contrary electricities in each of the respective discs with its circle of sectors.

Two discs of 16 inches diameter arranged in this way, with 24 sectors on each, will give a torrent of 5-inch sparks, and the machine is readily self-exciting.

A troublesome, and perhaps unexpected, difficulty,

however, occurs, which must be got over if the machine is to be of practical service—the tendency to a reversal of polarity during working. The remedy is easily provided by placing additional brushes to touch the sectors after they have passed the collector brushes; that is, at the top of one disc and at the bottom of the other. The reason for this will appear presently when reversal has been explained.

The defect of reversal is one that occurs more or less in nearly all influence machines except the Wimshurst, and the cause, though extremely simple, seems to have escaped general detection, so that much more mystery has been attached to it than is necessary.

Reversal is an obvious consequence of the induction which each charged disc exercises on its own earthed sector—the "self-induction" of the disc as it may be called. Each sector, at earthing, is under the influence not only of induction from the opposite disc, but also of induction from the contiguous surface of its own disc, and as the charge increases this inductive influence from its own disc at last overpowers that from the opposite disc, and so effects a charge of reversed sign. Holtz's memorable observation that when a metal comb is drawn over a highly charged glass plate a charge of opposite sign is left on the glass is only a special case of self-induction with consequent reversal.

The most satisfactory way to prevent this self-inductive influence would obviously be to keep the electricities of each disc "bound," except at the collectors. "Bound" electricity does not induce a charge in adjacent bodies. It is only when electricity is free that it is competent to do this. Now, as has already been pointed out, in the Wimshurst machine the electricities of each disc are held "bound" except at the collectors, and that is why self-induction, with consequent reversal, does not occur in the Wimshurst except under very strained conditions, while with the Voss and most other influence machines reversal is a constant source of trouble.

In the induction pump, which has been described above, the sectors of the overlapping portions of the disc have their charges "bound," and these are, therefore, incompetent to produce self-induction, but the sectors that precede the induction brushes are charged with free electricity, and it is when their charge is great that they are able to induce a reversed charge. To prevent this the additional brushes have to be provided as already described in order to neutralise the sectors at these portions of the discs' orbits.

There is one possibility with regard to self-induction that is worth considering, viz., the possibility of rendering it of service instead of preventing it as a hindrance. It is well known that Holtz turned it to account by utilising the charge of opposite sign which he found was left on a charged plate after passing a metal comb. A suggestive parallel to the self-induction of a charged disc occurs in dynamical electricity in the phenomenon named by Faraday the "self-induction" of the coil, *i.e.*, the inductive influence of each winding of the coil on the next winding. The question is whether, as in that case the self-induction of the coil is made to produce the "extra current," in some similar way the self-induction of the disc might not be made to produce "extra charge," and so made advantageous to the output. To effect this a machine totally different in construction from any of the present influence machines would have to be devised, but the problem is worth considering in view of the advantages which influence machines offer over the induction coil for X-ray work and even for wireless telegraphy.

The Great Meteorite of Willamette.

A full and interesting description is given in *Cosmos* of this meteorite, found in the hills of Western Oregon in 1902, and we reproduce one of the illustrations. This clearly shows the peculiar honeycombing of the base, the cause of which has been a matter of some speculation. The conditions contributing to affect the surface of the meteorite are peculiar. The air in front of it, during its rapid progress to the earth, is compressed to such an extent that it becomes almost like a solid body. The speed attained is calculated to be something like 50 miles a second. The friction should generate a temperature of about 5,000° Centigrade, sufficient to melt any material of which the meteorite is composed. This is mostly iron, with a small amount of nickel. The deep holes and furrows in the stone are, however, more probably the result of disintegration through chemical and atmospheric action on the earth. The meteorite, which is 10 feet in greatest length, weighs $13\frac{1}{2}$ tons.

"A Raised Beach in Anglesey."

To the Editors of "Knowledge."

Dear Sirs,—In your issue for July last, Prof. Bryan, F.R.S., refers to what he calls a "raised beach" resting upon boulder clay between Beaumaris and Penmon, Anglesey.

Beds of sand similar to that described by Prof. Bryan can be seen at Llanddona, Cemaes, and other places round the coast of the island; and at Towyn Trewan, Aberffraw and Newborough large tracts of land have been covered with sand. But surely these sands cannot be called "raised beaches" in any other sense than that of having been raised by the wind.

I do not doubt the facts mentioned by Prof. Bryan, but we must get stronger evidence than that of these "raised beaches" to establish the conclusion that "changes have taken place in the level of the earth," especially when we are dealing with a portion of the earth that has clearly been remarkably stable all along the geological ages from Precambrian times to the present.

Yours faithfully,

W. Edwards.

University College, Aberystwyth, July 24, 1905.

The Simplest Kind of Protoplasm.

A Note on the Free Growth of Bacteria and Torulæ in a solution of Neutral Ammonium Tartrate in Distilled Water.

By H. Charlton Bastian, M.A., M.D., F.R.S.

In his work on "The Structure and Functions of Bacteria," Prof. A. Fischer places the nitrifying Bacteria that were discovered and isolated in 1888-91 by Winogradsky among his group of "Prototrophic Bacteria." He says their life-processes are "characterised by an extremely primitive metabolism—a physiological humility which shows them to occupy the very lowest rung of the ladder of life." While on another page* he says the materials from which they build up their cells are "inorganic compounds of the very simplest character, carbon dioxide and ammonia, or nitrous acid, with a few mineral salts. They are thus prototrophic in the strictest sense of the word, for a simpler synthesis of proteids than theirs is scarcely conceivable." He further says:—"As might be expected in the case of organisms with oxidising functions, all the nitrifying Bacteria are ærobic. They require no light, and yet, in spite of this, are able to assimilate the CO_2 of the atmosphere."

His other two groups of Bacteria are supposed to be absolutely separated from this primitive group: the "Metatrophic Bacteria," under which are included most of the known forms, because they "cannot live unless they have organic substances at their disposal, both nitrogenous and carbonaceous"; and the "Paratrophic Bacteria," because they "can exist only within the living tissues of other organisms," that is, as true parasites.

It is the object of this article, however, to show (1) that a sharp distinction between these first two groups does not exist, seeing that common "Metatrophic Bacteria," as well as some Torulæ are capable of taking on life-processes even simpler than those shown by any of the hitherto described forms of the "Prototrophic Bacteria"; and (2) of showing further that such simplest of all life-processes are not of ærobic type.

The verification of these statements can be easily made. It will only be necessary to prepare solutions of neutral ammonium tartrate in distilled water, using about 0.65 of a gramme of the salt to 30 cubic centimetres of the water (that is ten grains to the ounce), and often the crystals have been dissolved to add to one of the solutions a single drop of a recently prepared turbid hay infusion, and to another a single drop of a recently prepared turbid infusion made from beef or mutton. The two solutions thus inoculated with common active Bacteria may then be placed in the dark within an incubator, maintained at a temperature of 30°—32° C. (86°—89° F.). In about 36 hours both fluids will be found to have become slightly opalescent, owing to the growth, as the microscope will show, of myriads of minute Bacteria, and occasionally of a number of very minute Torulæ.

Though these common Bacteria and Torulæ are thus capable of growing freely in the saline solution without the aid of light, I have found that light distinctly favours the process, since solutions similarly inoculated and left exposed to ordinary daylight have become turbid rather more quickly, even though the temperature to which the solutions has been exposed has been about 11° C. (20° F.) lower than that of the incubator.

In order to get rid of the complication caused by the presence even of a single drop of an organic infusion, such as was present at first, other solutions may be inoculated with Bacteria taken from one of the original solutions after five or six days, when their turbidity has become more marked. As the Bacteria in these solutions are probably less numerous and less vigorous than those in the organic infusions, three drops (rather than one) are now introduced into each of two other freshly-prepared ammonium tartrate solutions, one of which may be placed in the incubator as before, and the other left in a corked flask exposed to daylight; and at the lower temperature. The growth of these less vigorous Bacteria is now decidedly less rapid, and seems only capable of occurring at all freely when aided by daylight. In the flask on the table the fluid will become slightly opalescent in four or five days, and this opalescence increases for a few days, when a sediment begins to form. But the fluid in the incubator may show no distinct opalescence, even for a couple of weeks or more, though a very minute amount of sediment will accumulate.

Examination of the sediment taken from one of these second inoculation flasks which has been exposed to daylight will show masses of Bacteria, mixed with Torulæ or other Fungus spores, together with a delicate, much-twisted mycelium, as shown in Fig. 1.

So far there is nothing to show that the Bacteria and Torulæ which grow freely in the simple ammoniacal solution are not—as "Prototrophic Bacteria" generally are said to be—ærobic organisms taking their CO_2 from the atmosphere. That point, however, was settled by me as long ago as 1871, when I showed* that a solution of the same kind in a flask with a narrow neck might, with the aid of an air pump, be boiled at a temperature of about 90°F. (so as not to injure the organisms already contained in the fluid), and when the air had thus been expelled, the neck of the flask might be sealed during ebullition, by aid of the blow-pipe flame. Experiments conducted in this way showed that in the course of a few days the fluids became opalescent in the usual way within these sealed, airless flasks, and the microscope revealed the usual swarms of Bacteria. There was no mention in these experiments of Torulæ having been found—though I have little doubt that some of them were also present, as these organisms are well known to be generally anærobic in their mode of growth.

My claim that the organisms growing in this solution of ammonium tartrate in distilled water are building up protoplasm in the simplest known manner may be objected to on the ground of the ultimate organic origin of the tartaric acid, but I am told by Sir William Ramsay that "ammonium tartrate can be synthesised from inorganic material, and this substance is, so far as we know, absolutely identical with ammonium tartrate derived from tartaric acid extracted from wine-lees."

Seeing that the formula of neutral ammonium tartrate is $(NH_4)_2\ C_4\ H_4\ O_4$, if there were no impurity in the solution, the micro-organisms would have to build up their protoplasm in some way with the aid only of C, H, O, and N—which seems almost incredible. I may say that the ammonium tartrate used was specially

* *Loc. Cit. Transln*, 1900, pp. 48 and 106.

* *The Modes of Origin of Lowest Organisms*, p. 90.

prepared for me, some years since, by Messrs. Hopkin and Williams, and that the solutions were made in small flasks of hard, Bohemian glass. Such solutions were formerly twice analysed for me by a skilled chemist, who reported that not the least trace of either sulphur or phosphorus could be detected. Sir William Ramsay has, however, been kind enough to analyse another specimen of the solution for me after it had been in the flask for five days* and his report is that the "liquid contained an excessively minute trace of sulphur, probably as sulphate; but no phosphoric acid could be detected by the molybdate of ammonium test."

Looking, therefore, to the fact that the nitrifying Bacteria would have at their disposal the "few mineral salts" referred to by Fischer, we may safely assume that the micro-organisms growing in this solution of ammonium tartrate, contaminated only by an "excessively minute trace of sulphur," have, in reality, been building up the simplest known variety of protoplasm.

Fig. 1 (x 375).

But how much the process would be aided by a little phosphorus may easily be shown by the addition of three grains of sodium phosphate to the solution. An inoculated ammonium tartrate solution with this addition will become turbid more quickly, and will soon yield a far larger amount of micro-organisms.

This subject seems to me one chiefly of biological and chemical interest, and to be of altogether less importance on its botanical side. Looking to the nature of the primary inoculating material, it was only to be expected that several different kinds of common Bacteria would be found growing in the solutions, and this has proved to be the case. Dr. Gordon Holmes, the Director of the "Research Fund" at the National Hospital, kindly made a gelatine plate-culture from a second fluid, the first having been inoculated with a drop of a turbid hay infusion, and he reports that there were at least seven different kinds of Bacteria found —Cocci, Diplococci, Bacilli, and a kind of Streptothrix; while a miroscopical examination of some of the sediment from the same flask showed, in addition to abundance of Bacteria, a large number of Fungus spores, together with a peculiar spiral and twisted mycelium, such as may be seen in Fig. 1.

It certainly is very remarkable that these common micro-organisms, previously carrying on their life processes in organic infusions, should be able so rapidly to adapt themselves to an entirely different metabolism. It is much to be desired that some skilled chemists should take the matter up, and endeavour to throw some light upon the steps by which this marvellously simple synthesis of living matter is brought about.

* The Solution was one which had been inoculated with three drops from a first solution, and, having been in the dark incubator, it showed no trace of opalescence.

Star Map.—No. 6.

Leo, Cancer.

This map may be of special interest this month, since it shows the region in which the Sun will be at the time of the eclipse on August 30. The Sun's R.A. (on the Ecliptic) will then be X. h. 32 m., so that it will be close to ρ Leonis, and within about 7° of Regulus. Mercury at that time will be within 4° of the Sun, S. of 48 Leonis. Venus will also be within the map, on the borders of Gemini and Cancer. Dec. 19° 57′ 40″.

In the upper left-hand corner are some of the principal stars of the Great Bear, while to the right lay the "Twins," Castor and Pollux, and lower down is Procyon.

Among the more specially interesting objects included are—

α *Geminorum* (*Castor*) VII. h. 28 m. + 32° 5′. A complicated system. A double star, magnitudes 2·0 and 2·8, distant 5″·7. One of these stars is also found to be a spectroscopic binary with a large dark companion, while a smaller and more distant star shares in the proper motion.

α *Canis Minoris* (*Procyon*), VII. h. 34 m. + 5° 28′. Magnitude 0·5. Has a faint but massive companion star, which was one of the first "dark" stars discovered (in 1840).

ζ *Cancri*, VIII. h. 6 m. + 17° 59′. This is another complication of several stars. Two stars of 5 and 5·7 magnitudes revolve around one another in 60 years at a distance of less than 1″. A third star, of 5·5 magnitude, revolves around these in an opposite direction, and accompanying this is a dark companion.

ϵ *Hydræ*, VIII. h. 42 m. + 6° 50′. A triple star. Two, of magnitudes 4 and 6, are only 0″·13 apart, and present a yellow colour. The third star, of 7th magnitude and distant 3″·47, is blue.

α *Leonis* (*Regulus*), X. h. 3 m. + 12° 25′. Magnitude 1·3.

γ *Leonis* (*Algeiba*), X. h. 14 m. + 20° 19′. A double star, magnitudes 2 and 4, distant 3″·8. Yellow colour.

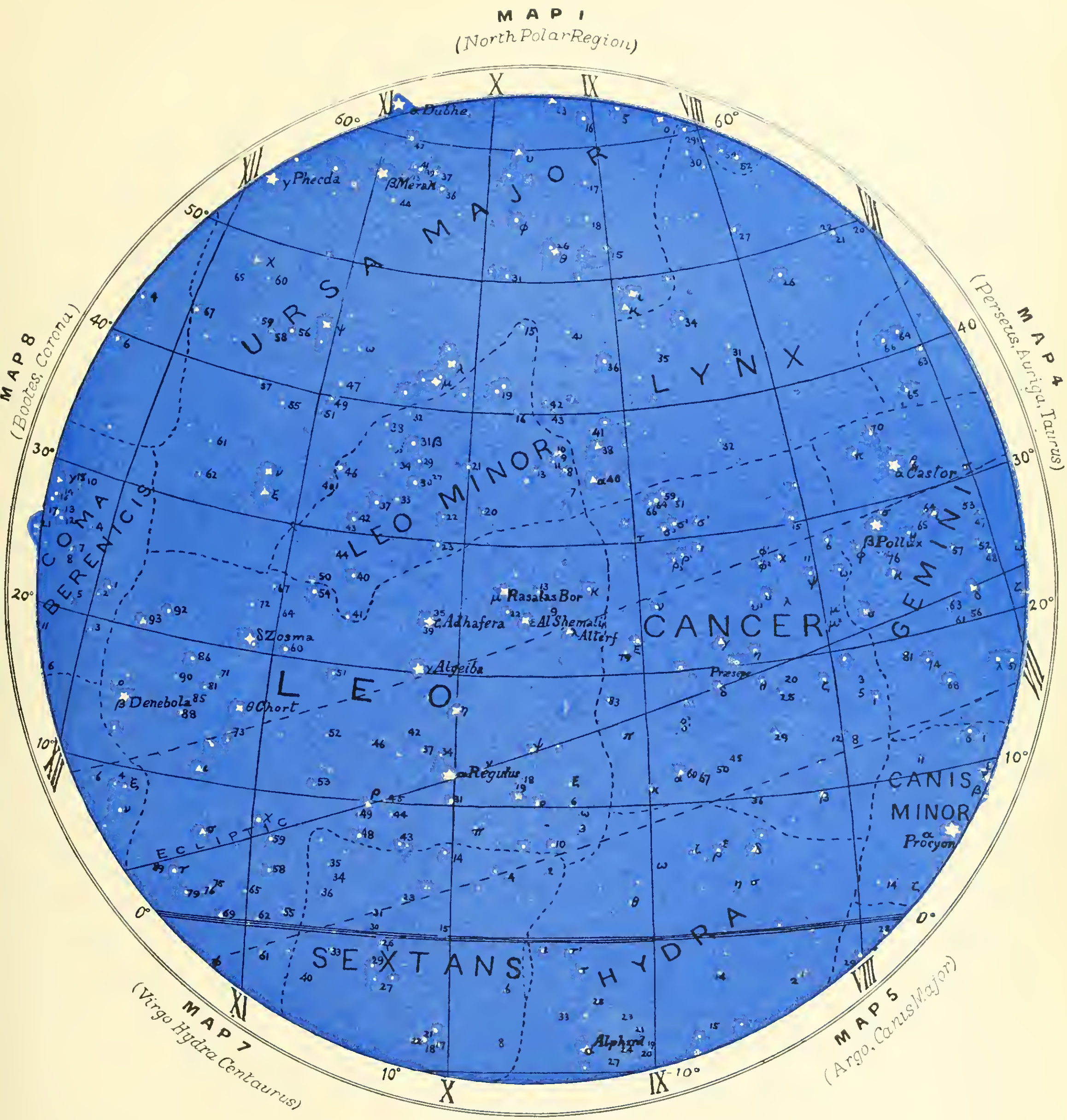
ξ *Ursæ Majoris*, XI. h. 13 m. + 32° 6′. A double star of 4th and 5th magnitude, distant 2″·3.

Leonis, XI. h. 19 m. + 11° 5′. A double star, yellow and blue, distant 2″·17.

1830 Groombridge (mag. 6·4), XI. h. 46 m. + 51° 30′, has the greatest proper motion of any star, amounting to 3″·98 in R.A. and + 5″·8 in decln.

In the centre of Cancer is the large cluster, not nebulous, known as Præsepe, "the Manger" (Ptolemy), or, according to some authorities, the "Beehive." Visible to the naked eye as a small cloud. Forty-five stars have been definitely located.

MAP No. 6.



BRIGHTNESS.

- 1st Mag.
- 2nd ,,
- 3rd ,,
- 4th ,,
- 5th ,,
- 6th ,,
- Variable.
- Nebula.

MAP No. 6.

Leo, Cancer.

The International Ornithological Congress

By W. P. Pycraft.

The Fourth International Ornithological Congress ended on June 17th, a really memorable session. The standard of papers presented was a high one, and though, perhaps, striking originality of thought, save in one or two cases, is not conspicuous among them, yet almost all show the grip of the specialist, a thing much to be desired, if the specialist have the knack, which many certainly do not have, of making himself intelligible to his fellow-workers in other fields.

Of the President's address we can say but little, for the President himself said little, rightly remarking that this could best be digested after its appearance in print. He chose to divide his discourse between two very different subjects—the history of the foundation and progress of the British Museum, with especial reference to the department of natural history, and of ornithology in particular, and that very fascinating theme, geographical distribution. Though many of us were aware that the nucleus of the present British Museum began with the acquisition of the collection of Sir Hans Sloane, probably few know that this was purchased, with Montagu House designed to hold the collection, by means of a lottery. Yet such is the case.

After the address came the appointment of Presidents of Sections, and in the afternoon the real work of the Congress began.

Of the many papers read, a large proportion were necessarily of a very technical character, yet every section was well attended.

It is curious that only two papers were read which dealt with museums in regard to ornithology, and of these only one was professedly devoted to this subject. This was submitted by Mr. Frank B. Chapman, of the American Museum of Natural History, New York. He dealt with the question, "What constitutes a museum collection of birds?" Helpful and suggestive, it was rendered yet more useful by a series of beautiful lantern slides, and these, it is to be hoped, will form the illustrations to his paper. In the course of his remarks, he referred in terms of the highest praise to our own Museum of Natural History, which, he said, he regarded as the most perfect institution of its kind which he had ever seen.

Besides this, Mr. Chapman read two other papers—"A Contribution to the Life History of the American Flamingo" and "A Contribution to the Life History of the Brown Pelican." These two essays were of quite remarkable interest, and were illustrated by a superb collection of slides. They were, indeed, models of how "bird-watching," as some would have us call observation of this kind, should be done. The papers of Dr. Willson and Mr. Bruce on the results of their ornithological work in the Antarctic formed no less striking proofs of what can be done in the field by men who are trained to observe. The testimony to the strenuousness of the struggle for existence, indeed, has never been more graphically demonstrated than by Dr. Willson on this occasion.

Dr. Dwight (New York) contributed two extremely interesting papers on peculiarly difficult subjects:—"The Significance of Sequence in Moults and Plumages," and "Some Phases of Wear in Feathers." These are subjects which promise to yield a good harvest to the patient investigator, yet in this country they have received but scant attention, though some of our commonest native birds illustrate many of the more remarkable exceptions to the general rule of moults and the phases of immature dress. How many, for example, of our field ornithologists could describe the phases of plumage which the gannet passes through before attaining maturity?

Mr. J. L. Bonhote gave an admirable summary of the experiments he is conducting on the hybridization of ducks, illustrated by lantern slides. Though too complex for the majority of his hearers to follow, when presented with the facts in the necessarily rapid survey he was compelled to give, yet all agreed that these experiments had yielded very substantial results.

Bird protection very properly came in for its share of attention. This very difficult problem was discussed from many points of view. Mr. Digby Piggott gave a lucid summary of the ridiculous anomalies to be found in our present system of legislation, while Mr. Frank Lemon gave an equally helpful and thoughtful paper on the "Rationale of Bird Protection," which gave rise to considerable discussion.

For the first time, we believe, in the history of the Ornithological Society, "aviculture" found a place in its deliberations, Mr. D. Seth-Smith reading a most useful and instructive paper on "The Importance of Aviculture as an Aid to the Study of Ornithology." This was undoubtedly a valuable contribution to a most neglected subject.

But, perhaps, the great feature of the Congress was the lecture by the Hon. Walter Rothschild on "Extinct and Vanishing Birds." This will long be remembered as a masterly exposition of a very difficult subject, illustrated in a manner absolutely unique in the annals of ornithology.

To hear the lecture the whole Congress was conveyed, by the generosity of Mr. Rothschild, by special train to his museum at Tring Park. Here, in a large hall, were gathered together a vast collection of birds, either already extinct or fast becoming so, and these were inspected after the lecture.

Among the more remarkable of these exhibits were skeletons of the Moa and Æpyornis, as well as eggs of these birds, and stuffed examples of the rare Labrador Duck, Black Emu of Kangaroo Island, and the starling of Reunion (Fregilupus). Of the Dwarf or Black Emu only two skins are known. The number of birds in danger of extermination is unfortunately a large one, and this was painfully evident from the number of specimens displayed here. To make this collection more perfect Mr. Rothschild enlisted the services of some of our best known bird artists to prepare coloured restorations of some of the more striking forms which he was otherwise unable to illustrate. Among these we must specially refer to a really wonderful restoration, in oils, of the small Dinornis by Mr. G. E. Lodge. Mr. Frohawk contributed three striking pictures to this number—a Moa 15 feet high, the Giant Rail *Leguatia*, and the Solitaire.

But the end of the Congress is not yet. Though officially over on Saturday, June 17th there remain at the time of writing three very important items to fulfil—the excursion to Woburn Abbey to see the collection of wild animals kept by his Grace the Duke of Bedford, the visit to Cambridge, and the trip to Bridlington to visit the breeding cliffs of the guillemots. With this last, the most successful of the Ornithological Congresses yet held will come to a close.

Seaweeds:
A Holiday Paper for Field Botanists.

By DAVID W. BEVAN, Scarborough F.N. Society.

MOST botanists will, during their summer holidays, stick to the cliff and sand dune to seek *maritime*, not *marine*, plants. But it seems a pity that the latter should receive such scant attention. The beauty of many of the sea weeds is so exquisite, the way of life of others so interesting, that the field botanist cannot afford to miss them, and this is specially the case if he possesses a microscope. A shore that possesses a rocky reef, laid bare twice daily by the ebbing tide, is the best collecting ground, and as this article is penned at Scarborough it may not be out of place to mention that it is an ideal place in this respect. Arrived on the scene with a tin canister or two—a bottle of sea-water is also needed, but should not be carried on the slippery rocks—we proceed to take "snippings" of everything we come across.

It is noticed at the outset that the seaweeds tend to be clannish. The green ones favour, on the whole, the part towards high-tide mark, and the brown the part between tide marks. A good many red flourish there, too, but as a rule their red is a very poor red—nearly black or faded yellow. It is mostly in the deepest pools, and out in those deeper reaches that are never laid bare by the tide that those splendid crimsons and rosy reds occur that are the typical colours of the red seaweeds. To get these last we must wait till a storm tears them from their moorings and casts them on the shore.

The brown seaweeds are the giants of the shore, and claim our attention very much, for they are slippery customers. Growing on the margins of all the pools are the Wracks (*Fucus*), all of which branch, by repeated division into two (dichotomy), much like the flowering stalk of the Stitchwort, but always in the same plane, so that if we spread a plant out on the sand it forms a perfectly flat, fan-shaped frond. The Bladder Wrack (*F. vesiculosus*) has paired bladders in the frond (Fig. 1). The Serrated Wrack (*F. serratus*)

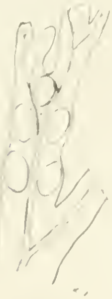


Fig. 1.

Fig. 2.

is without bladders, and has, as its name indicates, a saw-like edge to the frond (Fig. 2). The Knotted Wrack (*F. nodosus*) is "all stalk," with big bladders in the stalk like a string of oval beads and its frond has no flat, leafy expansion or blade. It does not divide dichotomously, and in other respects, stated further on it differs from the typical Fucus (Fig. 3). This plant seems particularly happy in tidal river mouths where the water is only slightly salt. *F. canaliculatus* has channelled fronds, and grows only three to six inches high.

Then there is the fine, bushy Sea Oak (*Halidrys siliquosa*) in great plenty in the deeper pools, known by its pod-like bladders, which are seen, on being split by a penknife, to contain several storeys (Fig. 4). Lastly,

Fig. 3.

Fig. 4.

not to stay among the Wracks too long, there is the delightful Sea-thong (*Himanthalia lorea*), growing at dead low-tide mark. There they grow in scores—well worth a snap-shot—like little brown mushrooms when young, but in their second year they put out a long strap-shaped dichotomous frond from two to three feet long, which is the reproductive part (Fig. 5).

Here at low water we see the Tangles (*Laminaria digitata*), a stout stalk which may reach three feet

Fig. 5.

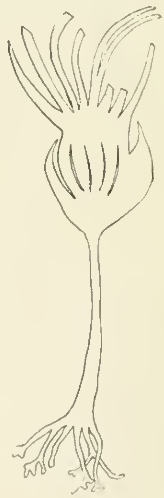


Fig. 6.

long or more, bearing a broad flat mass of ribbons on the top. This upper frond is shed in spring and a new one grows there and splits into ribbons in due course. One sometimes finds both old and new fronds on the one stalk (Fig. 6).

The most interesting thing about the Fucoids is their reproductive arrangements. Everyone has noticed the swollen ends of the fronds of the Wracks beset with

tiny holes. These holes are the conceptacles, inside which the eggs and sperm are formed. Though most plentiful in early spring they are to be found all the year round. The fronds with bright orange tips are male and the dull brown ones are female.

Now, on a bright day when the tide is out we can easily find tiny drops of brown or orange jelly which have issued from the conceptacles. The one kind contains the ova, the other the male elements, and it is now our business to bring these together under the microscope. It is best to break off the tips of the fertile fronds, keeping the sexes separate, and lay them on two *dry* saucers, placing them in a good draught for some hours. A plentiful supply of mucilage will appear, and if a little of the brown is now added to a single drop of sea-water on a glass slip and examined with a low power, a very pretty sight presents itself. Numerous bags (oogonia) of ova, eight in a bag, are

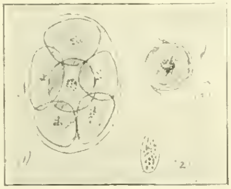


Fig. 7.

FUCUS. (1.) Oogonium (egg-case). 6 of the 8 ova are visible.
(2.) Antheridium with spermatozoa.
(3.) A discharged egg cell with 4 spermatozoa attacking it.

lying about (Fig. 7). But the rising tide (represented by the drop of sea-water), begins to act on them; the wall of the oogonium disappears, and out float eight beautiful round brown eggs.

When the orange-coloured jelly is similarly treated —a higher power is desirable—we see large numbers of much smaller cells, which in like manner discharge their contents. But instead of ova we see immense numbers of minute male cells, which no sooner find themselves in the sea (a drop of water is an ocean to them) than they put out two cilia and begin to swim hurriedly, and *apparently* aimlessly, about. We say *apparently*, for if one of these spermatozoa can succeed in reaching and penetrating a female (egg) cell it will have fulfilled its destiny. Then, and not till then, can the egg develop to form a new Wrack.

When, therefore, we add a few ova to a drop of water containing sperm, immediately the male cells cease their aimless wanderings and hasten to the side of the female cell. But why? They have no eyes to see the beautiful roundness of her form—no senses that we know anything about. They are only tiny bits of protoplasm, and yet there is in them a *something*, a sentiment—call it chemotaxis or what you will—we, out for a holiday, prefer to regard it as the very germ and essence of the tender passion. Scores, hundreds, of the swimming cells surround the female body, which whirls round and round on its axis, not exactly from giddiness, but from the force of the attentions it receives. At last one of the male bodies penetrates it, fertilization is effected, and the romance is at an end.

If a number of conceptacles of both kinds, with the mucilage on them, are washed in a basin of water and the contents examined daily, we may trace the first stages in the germination of the fertilized egg cells—and, of course, *draw* them.

Several of the other brown seaweeds present the same features—with variations. In the Sea Thongs, the whole thong borne by the mushroom-like frond is beset with conceptacles. Then the number of eggs in a bag varies in different plants. The Knotted Wrack has only four ova in a group, the Channelled Wrack two. These differences are now considered of sufficient importance to warrant the establishment of two new genera. *F. nodosus*, which we have already seen to differ a good deal from the other wracks, is now *Ascophyllum nodosum;* and the other is *Pelvetia canaliculata*.

A fair average specimen of *F. serratus*, selected by chance, had 18 fertile branches that had already discharged ova, and 16 others not fully ripe. Of the 18 a chance one had over 300 conceptacle pores on one side, and presumably the same number on the other side. Now, in the course of a single season, the egg-cases, discharged as fast as they ripen, may be put, at a very moderate estimate indeed, at a dozen from a single conceptacle. Each oogonium contains eight ova. Total number of ova, without considering the 16 immature branches, considerably over half a million. The extraordinary plenty of the brown seaweeds ceases to be a matter of surprise. The sea near the shore must sometimes teem with ova. They settle down everywhere, and at once attach themselves to the rock and begin to develop into new plants.

Several other brown varieties will be met with which space forbids us to describe. Two very common and very handsome relations of the Giant Tangles, bearing only a single ribbon, and very much smaller in size (*Laminaria saccharina* and *L. bulbosa*) are pretty sure to turn up. Then there are several smaller plants, much easier to dry and mount than those we have mentioned, though perhaps less interesting in themselves.

Here we take leave of the brown seaweeds unless we choose to emulate the "tripper," who carries home with him as a trophy a trailing handful of wrack—a silent monitor, in consequence of its saltness, to warn him of the coming storm. In the next article we shall deal with the "Red Seaweeds," and in it we shall have something to say about collecting and preserving.

The Gegenschein and Zodiacal Light.

Sirs,—It would be interesting to know whether any special observations have been made, or can be made, on the above-named little-understood phenomena during a total eclipse of the Sun.

Two theories have been suggested regarding the origin of the Gegenschein. One is that it is the reflection of the Sun's light from meteorites at a distance, which being opposite the Sun are at "full moon." The other is that it is the forms of the Sun's rays reflected in our atmosphere. Now if the former theory be correct, a total eclipse should not have any material effect upon the appearance, but if the latter, there should be a distinct diminution of light at the moment of eclipse.

So too with the Zodiacal Light. Some consider it as an atmospheric phenomena, others as a solar adjunct. And much might be done to elucidate this point if careful observations were made during the occurrence of a total eclipse.

Yours truly,
P. R. R.

Acetylene as an Explosive.

SOME interesting researches have recently been made by M. Gréhant on explosive mixtures of air and acetylene and corresponding mixtures of air and oil gas. The tests were made in tubes of 50 cubic centimetres for the acetylene and of 90 cubic centimetres for the oil gas. The mixtures were exploded by an electrically-heated incandescent wire. The following are the results obtained :—

Volume of gas.	Volume of air.	Percentage of gas.	With acetylene.	With Oil-gas.
1	1	50·0	Burns with smoky flame.	Does not burn.
1	2	33·3	Ditto.	Ditto.
1	3	25·0	Detonates with deposition of carbon.	Feeble detonation.
1	4	20·0	Stronger detonation without deposition.	Stronger detonation.
1	5	16·7	Strong detonation.	Strong detonation.
1	6	14·3	Ditto.	Ditto.
1	7	12·5	Very strong detonation	Less strong.
1	8	11·1	Ditto.	Ditto.
1	9	10·0	Ditto.	Feeble detonation.
1	10	9·9	Strong detonation.	Ditto.
1	11	8·3	Ditto.	Very feeble detonation.
1	12	7·7	Ditto.	Does not ignite.
1	13	7·1	Less strong.	Ditto.
1	14	6·7	Ditto.	Ditto.
1	15	6·3	Feeble detonation.	Ditto.
1	19	5·0	Very feeble detonation.	Ditto.
1	20	4·8	Burns without detonation.	Ditto.

These results show that the detonations obtained with acetylene are more violent than those with oil-gas, but that, nevertheless, the acetylene is less dangerous than oil-gas.

CORRESPONDENCE.

The Visibility of Planets in Daylight.

SIRS,—Some of your readers may be interested in knowing that it is quite possible for them to see the planet Venus in broad daylight, with the naked eye, and no apparatus of any sort. I have for the last six months or so constantly seen her shining high up in the heavens in the blazing light of a South African sun at mid-day. It merely requires one to take a rough measurement on a stick, and one evening, about sunset, to see how far she is from the sun, and the direction. You can then, next day, discover her without opera glasses or any other help. Of course, at first it is extremely hard to find the planet, but after a little practice the eye picks it up easily. I have found it on a cloudless sunny day while riding along the veld. I have also succeeded in seeing Jupiter in full sunlight in the same way, and lately I have, owing to this practice, managed to find Sirius and Canopus with the sun some way above the horizon, and shining brightly. It is not only owing to the clear atmosphere of this country, as I have found Venus on a somewhat hazy day, certainly far less clear than one often gets it in England. It would be interesting also to know if any of your readers have seen the waning moon within 40 hours or so of new moon. By careful search I have succeeded in seeing it about that time from new moon, in midday in a cloudless sky, nearly overhead. As she is so exceedingly thin and close to the sun, you can imagine how hard it is to find her with the naked eye. Those novelists or poets who have been decried by the critics for making the crescent moon shine overhead, will now be able to refer to my statement in verification of their words.

I am, yours truly,
T. B. BLATHWAYT.

Kokstad, E. Griqualand, S. Africa,
April 29, 1905.

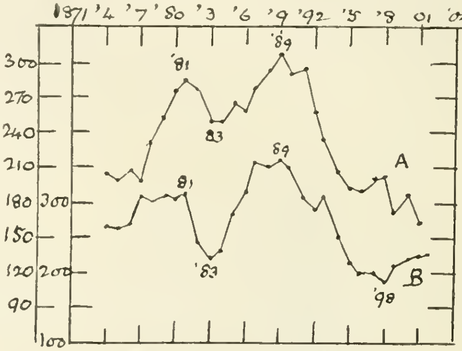
[As regards Venus, it is well known that the planet "is so brilliant that there is no real difficulty in seeing her with the naked eye in full sunshine, or indeed at high noon."—*Maunder, "Astronomy without a Telescope,"* p. 147.—ED.]

London Fog and Frost.

SIRS,—In a paper lately read before the Royal Meteorological Society, the author, Mr. F. J. Brodie, gave some useful tabulated data of fog observed in London during twenty years, and came to the sanguine conclusion that the great decrease of fog in recent years points to a victory over the fiend by smoke abatement in various ways.

Without affirming that there is no improvement from this cause, or questioning the obvious wisdom of efforts to do away with smoke, I cannot but think that climatic influences are the chief factor in the improvement observed.

If we combine Mr. Brodie's figures for autumn and winter, and smoothe the series by sums of five (*i.e.*, adding the first five,



A.—Smoothed curve of Fog-days.
B.— „ „ Frost-days.

then the second to the sixth, and so on), we get the curve A; and doing the same with the totals of frost days in winter seasons at Greenwich, we have the curve B.

This is obviously a rough comparison, and remembering also the uncertainty attaching to fog determinations, we should not look for very exact correspondence in these curves; but there is general agreement, and, in particular, while the fog curve shows a long general decline from about 1889, the frost curve does the same.

If we get up again to the 1889 level of frost, will the fog curve fall short of *its* level for that year? That remains to be seen; and before giving rein to the triumphant spirit, we had better first see, perhaps!

I am yours, &c.,
ALEX. B. MACDOWALL.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

The Canals of Mars Photographed.

A SHORT time back the important news was telegraphed from Lowell Observatory that the much-criticised markings on the Martian surface had been successfully photographed by Mr. Lampland, and the last circular from the observatory not only confirms this, but contains an actual print from the negative showing the markings.

Many attempts have been made at the Lowell Observatory at Flagstaff, Arizona, to photograph the canals of Mars, commencing with the success of Mr. Douglass in 1901, when, by

using a Wallace screen, he secured a good picture of the Mare Acidalium. Encouraging as the result was, there were no signs of any canal markings. The two chief difficulties were the variation of the atmospheric tremors, and the insufficient sensitiveness of the photographic plates. The endeavours to get rid of these errors resulted in the ordering of a film camera wherewith a succession of pictures could be rapidly taken behind a Wallace screen; and with this arrangement Mr. Lampland has got his interesting results. A most important item, however, has been the suitable cutting down of the aperture of the photographic telescope to suit the particular state of atmosphere at the time of observation.

From the many plates secured, the one taken on May 11 was selected for the reproduction sent with the circular. Side by side with the print is placed a photograph of a drawing by Professor Lowell, made before the camera was placed in position, and this serves the double purpose of showing the confirmation by the photograph of the objectivity of the visual observation, and at the same time of serving as a chart to it.

The print is enlarged 1·8 times from the original negative; and not only are the canals easily discernible, but it is evident that they are *continuous* lines, and not syntheses of other markings, as has been suggested by various writers.

An additional note by Mr. Lampland states that the photographs were obtained with the 24-inch Clark refractor of 386 inches focal length. The camera carries a negative enlarging lens, the equivalent focal length of the combination being 148 ft. The camera carries a plate holder for $3\frac{1}{4} \times 4\frac{1}{4}$ plates, movable perpendicularly to the optical axis, thus permitting a dozen or more exposures on the planet, for the focal length given, to be made on the same plate.

A colour screen is placed immediately in front of the plate, separated by a small space to minimise the effect of small particles of dust or other extraneous matter. Cramer's isochromatic plates were used, this make being chosen on account of the fact that one of the maxima of the curve of sensitiveness of the plate coincides almost exactly with the vertex of the colour curve of the large objective. The best results have been obtained with the 24-inch stopped down to 9 or 12 inches, and the exposures were usually about eight seconds each with the 12-inch aperture.

Spectroscopic Observations of Mercury during Solar Eclipse.

Dr. G. Johnstone Stoney draws attention to the opportunity which will be afforded during the approaching total solar eclipse on August 30 of obtaining important observations of the planet Mercury. At that time Mercury will be very close to the line joining the Earth and the Sun; its centre is 2° 54′ South, and 2° 54′ preceding the Sun, so that the distance is only about 4° 6′, and the illuminated portion of the planet's disc will be seen as a very fine crescent. If the planet possesses any appreciable atmosphere, the horns of this crescent will be prolonged by the effects of atmospheric refraction, and micrometric measurements of the degree of such elongation would furnish material for calculating the extent of the planetary atmosphere. For such an observation a telescope magnifying about 200 diameters would be desirable. Further important and interesting determinations may be made by treating the thin crescent as a slit, and viewing it through a spectroscope, as then the exact constitution of the atmosphere surrounding the planet might be ascertained.

Photographic Studies of the Planet Mars.

Quite recently a series of successful photographs of the planet Mars have been obtained under the direction of Professor W. H. Pickering at the Harvard College Observatory. In the spring of the present year the 11-inch Draper telescope was fitted with an enlarging lens, and it was found possible to obtain original negatives showing the disc of the planet on a scale of about 2″·5 to the millimeter.

The first photograph was obtained on March 31, and others were secured on April 1, 2, 8, 15, 16, 18, 23, 25, 27, 30. The first photograph showed clouds at both the limb and terminator, but no definite evidence of actual polar caps was visible on the photographs until April 23, when a large light area was clearly visible at the south pole. It did not appear dark enough for snow, but presented more the appearance of an extensive cloudy region. It remained visible on all the photographs since that date, although its intensity and size diminished somewhat. A minute light area appeared near the north pole of the planet on April 15, but was seen only with difficulty.

On the night of April 30, visual observations were made with the 24-inch reflector. The southern polar cap was clearly visible, extending far to the north in longitude 340°, but its intensity was only slight, little exceeding that of the limb in other regions. It is considered probable that when the Martian clouds disperse snow may be found lying in their places.

Considering briefly the aspect of the planet at these times, we notice that the heliocentric co-longitudes on April 15 and 23 were 216° and 220° respectively. These positions would correspond on the earth to August 3 and 7, or to near the end of the winter of the southern hemisphere. Snow seldom comes earlier on Mars. It will be very interesting to observe if the brown tint described by Lowell as characteristic of the Mare Erythræium will become changed to its normal colour. This change of colour with the seasons may yet afford the best proof of the existence of vegetation upon the planet Mars.

Ephemeris for Observations of Comet 1904 I.

This Comet will be somewhat near the Sun, and should be looked for a little before sunrise, in the constellation Lynx, above Cancer.

1905.		R.A.			Declination.			Relative Brightness.
		H.	M.	S.		°	′	
Aug.	2	8	33	15	+	43	11·5	0·028
	4		34	15		43	4·7	
	6		35	14		42	58·1	0·c28
	8		36	12		42	51·8	
	10		37	9		42	45·7	0·028
	12		38	5		42	39·9	
	14		39	0		42	34·3	0·027
	16		39	54		42	29·0	
	18		40	48		42	23·9	0·027
	20		41	40		42	19·1	
	22		42	31		42	14·6	0·027
	24		43	21		42	10·3	
	26		44	9		42	6·3	0·026
	28		44	56		42	2·5	
	30		45	42		41	59·0	0·026
Sept.	1		46	26		41	55·7	
	3	8	47	9	+	41	52·7	0·026

CHEMICAL.

By C. A. Mitchell, B.A. (Oxon.), F.I.C.

The Flashing of Arsenic Crystals.

Arsenious oxide, the ordinary *white arsenic* of commerce, forms two distinct modifications, differing from each other in specific gravity, melting point, and other physical properties. The vitreous modification is semi-transparent, but on exposure to the air gradually becomes opaque and of a yellowish tinge as it changes into the other variety. As far back as 1835 it was found by Rose that when the vitreous modification was dissolved in boiling hydrochloric acid the excess of uncombined arsenic separated out in minute crystalline octahedra from the solution on cooling, and that on shaking the contents of the flask in the dark a succession of brilliant flashes was emitted. The generally accepted explanation of this very beautiful phenomenon is that at the moment when the crystals separate the vitreous modification is suddenly transformed into the crystalline variety, the change being accompanied by a liberation of energy expressed in the form of light. It has recently been shown, however, by M. D. Gernez (*Comptes Rendus*, May, 1905), that this explanation is incorrect. He finds that if the flask be kept absolutely still the formation of

the crystals is unattended by any emission of light whatever, but that if the flask be shaken the crystals are ruptured by contact with the glass or each other and then produce the flash. The property is by no means a fugitive one, and the dry crystals will yield sparks months afterwards if rubbed with a glass rod. Moreover, contrary to the statements of the text books, the emission of light is produced as readily by crystals formed from the opaque variety of oxide as by those from the vitreous modification. The phenomenon is thus another instance of *triboluminescence*, the name given to the property possessed by many crystalline substances of emitting light when struck or rubbed. Herr Tchugaeff has shown that very many bodies possess the same power. Thus, of 400 substances examined by him, 121 were found to emit light, the alkaloids, as a class, being particularly active, but only 6 out of 110 inorganic bodies showed the phenomenon. The colour of the light varied with the different substances, and its intensity could be classified according to an arbitrary scale in which uranium nitrate was taken as typical of the first class, tartaric acid of the second, and ammonium oxalate of the third. The nature of the light emitted by arsenious oxide has also been studied by M. Guinchant, who finds that it has a continuous spectrum in the visible part of which the green and yellow rays predominate, though red rays are also present. The light does not affect an electroscope, but has a strong action upon a photographic plate, and is apparently identical in character with the light emitted by solid bodies in a state of incandescence.

The Physiological Action of Air in Crowded Rooms.

It is a commonly accepted belief that the unpleasant effects produced on the human system by the air in overcrowded rooms is due to volatile products given off by the skin and lungs; but experiments made by Dr. Paul of the Breslau Hygienic Institute appear to indicate that the main cause is the retention of heat by the body. Under normal conditions heat is lost by conduction, radiation, and evaporation of moisture, as well as during respiration. The loss of heat by conduction is to a large extent prevented in crowded rooms, in which the air is usually of a relatively high temperature, and contains a high proportion of moisture, while the loss by radiation is very incomplete when the body is surrounded by others at about the same temperature. In Dr. Paul's experiments it was found that headache and all the other unpleasant symptoms could be entirely prevented by regulation of the heat, even when the air was saturated with respiration products, and contained as much as 15 per cent. of carbon dioxide; whereas without this regulation of temperature they appeared even when absolutely pure air was breathed. The retention of heat could be demonstrated objectively by the rise in temperature of the skin.

The Action of Hydrogen Peroxide on a Photographic Plate in the Dark.

Systematic experiments have been made by Dr. C. Otsuki, of Tokio, to determine the nature of the changes produced by hydrogen peroxide acting upon a photographic plate in the dark, and to test the assertion that the action of the reagent could penetrate through a sheet of metal (see "KNOWLEDGE & SCIENTIFIC NEWS," this Vol., p. 100). It was found that gelatin, celluloid, certain gums, and Canada balsam were permeable, but that paraffin, fish membrane, ebonite, glass, and metals were not. In the experiments with metals the greatest care was taken to insure the absence of minute holes, the thin films being examined under the microscope before and after the exposure. The metals used were zinc, copper, tin, an alloy of gold, silver, and platinum, brass, and aluminium in thin films ranging in thickness from about one thousandth to one tenth of a thousandth of an inch. Out of 47 experiments action upon the plate was only observed three times, and in each case minute holes were found to have been formed by the corrosive action of the hydrogen peroxide vapour upon the metal. The temperature had a considerable influence upon the reaction between the gelatin silver bromide and the hydrogen peroxide, lighter or darker zones in the image (Graetz's "border effect") being produced by small variations in different parts of the plate or between the plate and surrounding bodies. In some cases the borders were lighter than the centre, while in others the reverse was the case. It is not improbable that this may also account for the curious border produced by the action of wood upon a photographic plate in the present writer's experiment ("KNOWLEDGE & SCIENTIFIC NEWS," this Vol., p. 120), assuming that hydrogen peroxide was the active agent in this case. Professor Otsuki concludes that the action of hydrogen peroxide upon the silver bromide is to convert it into a lower bromide which can be reduced readily by the developing solution. It cannot be regarded as due to radiation.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Erosion in Freshwater Bay.

THE possibility of the sea breaking through what remain of the low-lying cliffs in Freshwater Bay and forming a junction with the waters of the sluggish Yare gives rise to many interesting geological considerations. It is not a little remarkable that a river should take its rise in such close proximity to the sea as does the Yare, and for an explanation we must look back to a geological time when the sea was much farther away to the south than it now is. Even within the historical period great changes have taken place in connection with the coast of the Isle of Wight, and the extent of the island has dwindled to its present dimensions. When, too, we look at the width of the valley of the Yare, one is apt to wonder how such a slow-flowing stream could ever have had the necessary force to carve a wide valley. The river is now, however, in its old age. Probably it would long since have been silted up, had there been a sufficient watershed to have ensured a plentiful supply of sedimentary material. Now, there is a chance of a new lease of life being given to it, if the dreaded possibility happens, and the sea leaps the barrier at Freshwater Bay, to join hands with the river itself. But there is another possibility of a different nature. Would it be worth while draining the upper reaches of the Yare? It would not be a difficult matter to prevent tidal action from having any influence beyond the town of Yarmouth; then much of what is almost stagnant water might be drained, and valuable land in Freshwater Bay saved from destruction.

The Tarns of Ticino.

In pursuance of Prof. E. J. Garwood's studies into the action of ice, an interesting paper has been read by him before the Geological Society, in which he deals with the formation of the Tarns of the Canton Ticino. Excavation by ice-action, so far as these lakes are concerned, finds no support in the paper in question. In some cases the ice must have invaded the district from the outside, and from several directions at once. The lakes appear for the most part to be due to structural peculiarities of the district, lying often in lines of junction, or indicating lines of weakness; while at the same time the presence of numerous springs gives rise to a belief that solution may have formed a not unimportant part in their formation.

Glacial (?) Geology.

Sir Henry Howorth is excellent company, whether in person or in his writings, and those who have enjoyed his humour as a *raconteur* will almost feel that he is playing an enormous joke at the expense of the geological world in launching his thousand-page work on "Ice and Water." Sir Henry is following up with his usual courage his contentions in regard to the generally accepted theories of ice-action and water-action, and those who have read and enjoyed "The Glacial Nightmare" and "The Mammoth and the Flood" will be prepared for this further exposition of his views. Almost as one crying alone in the wilderness, his works are full of excellent reading, and crowded with data, brought together with infinite patience, and if one is apt to develop too much into an extremist in any particular school of geology, one finds an agreeable corrective here.

Uintacrinus in the Croydon Chalk.

Dr. G. J. Hinde has found a very close resemblance to some of the higher zones of the chalk of the coast near Margate in the chalk of the tract between Russell Hill and Beddington, in Surrey. Hitherto the chalk hereabouts had been thought to belong to the zone of *Micraster cor-anguinum*, although when last year the third volume of the "Cretaceous Rocks of Great Britain" was published by the Geological Survey, it was anticipated that the zone of *Marsupites* was present. Doubts have now been set at rest by the discovery by Dr. Hinde of some test-plates of free-swimming crinoid *Marsupites*, with *Echinocorys scutatus*; and at the same time he discovered some smaller inconspicuous test-plates, which, on close examination, were found to belong to the unstalked free-swimming crinoid known now as *Uintacrinus*. These show the existence, near the place where the chalk disappears beneath the tertiaries, to re-appear on the north of London, of the lower portion of the *Marsupites*-zone, called by Dr. Rowe the "Band of Uintacrinus." The fossils found by Dr. Rowe in this band in coast-sections near Margate agree almost identically with those found by Dr. Hinde near Beddington.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

The Scent of Sitting Birds.

Mr. Tegetmeier, at the last meeting of the British Ornithologists' Club, made some interesting observations on the scentless nature of birds when sitting on their eggs. He contended that the physiological explanation of this was well known, and that the "vicarious secretions" causing the scent were retained within the body in sitting birds, and passed into the cloaca, to be eventually voided with the fæces. The odour of the fæces dropped by a sitting bird was, he said, totally different from that passed at other times, and their particularly offensive smell was caused by these secretions.

We venture to think that this explanation will not stand the test of investigation. Birds are unique in the glandless nature of their skin, even sweat glands being absent. Whatever smell escapes is probably exuded by the feet; hence the care taken by many birds to fly straight off from the nest, and so prevent the tell-tale traces, which would otherwise be left, of the whereabouts of their eggs. The unusual offensiveness of the fæces may be explained by their long retention in the cloaca.

The Eggs of the Knot.

Dr. Bianchi, of the St. Petersburg Museum, brought with him, on his recent visit to London, a collection of twelve eggs of the Knot (*Tringa canutus*), and a few nestlings, and these he exhibited at the last meeting of the British Ornithologists' Club.

The nestlings of this bird were discovered by Colonel Fielden when in the Arctic expedition of 1876; but the eggs remained unknown till discovered by the late Dr. Walters on an expedition to the Taimyr Peninsula in 1901. To allay all doubt as to the identity of these eggs the parent birds were also taken. The eggs are remarkable for the great variability which they show in size, form, and colour. The ground-colour ranged from "pale clay" to pale yellowish white, and pale green. The markings took the form of dirty-brown and violet-grey spots, tending to cluster at the blunt end of the egg, and varying much in size.

Dr. Walters was the medical attendant and ornithologist of the expedition, and died before it returned, at Kotelny Island, December 21, 1902.

Nesting of the Scoter in Ireland.

The *Field*, July 15, contains a most interesting account by Major Trevelyan of his discovery of the breeding of the Common Scoter (*Œdemia nigra*) "on one of the loughs in Ireland" during this summer. He had the good fortune to discover the female sitting on a nest of eight eggs in June last. This was placed under a small bush on an island. On July 1, he found her with five young ones swimming about in the lough. Tufted ducks were breeding here in some numbers, and in several cases it would appear that more than one female was laying in the same nest, since as many as twenty-one eggs were found in one case and nineteen in another! Two other nests contained sixteen and eighteen eggs respectively. Gulls seem to levy a heavy toll on the young of these birds, as well as on the eggs.

The exact locality of this new breeding-ground is very wisely withheld.

Waxwings in Berkshire.

In the Bulletin of the last meeting of the British Ornithologists' Club, Major F. W. Proctor records the occurrence of a pair of Waxwings (*Ampelis garrulus*) at Maidenhead Thicket on April 11. They were, we learn, unmolested, but whether they remained to breed has so far not been ascertained.

Marsh-Warbler Nesting in East Kent.

Mr. Collingwood Ingram at the meeting above referred to exhibited an egg of the Marsh-Warbler (*Aerocephalus palustris*) taken from a nest of five. The remaining four eggs were left and hatched out. This is believed to be the first authentic instance of the breeding of this species in Kent. The nest was placed in on the shoots of a young ash-tree about three feet from the ground. It was composed of dried grass-stalks and lined with horse-hair and cocoa-nut fibre, the latter procured from a neighbouring hop-garden.

The Western Black-Eared Chat at Hove.

An example of the Black-eared Chat (*Saxicola albicollis caterinæ*) was killed at Hove on May 22, 1905. This is the second recorded instance of this bird in Sussex; the first example having been killed three years ago. Both cases were reported to the British Ornithologists' Union by Mr. R. Butterfield, who saw each bird in the flesh.

PHYSICAL.

By Alfred W. Porter, B.Sc.

A Scientific Essential.

And above everything the scientist must foresee. Carlyle wrote somewhere to this effect: "The fact alone matters; *John Sansterre passed this place*; there is a reality for which I would give all the theories of the world!" Carlyle was a compatriot of Bacon, but Bacon would not have said that. That is the language of the historian. The physicist would say rather: John Sansterre passed this way! That is nothing to me, since he will not pass this way again.

Poincaré, La Science et l'hypothèse.

The Alpha Stream.

Professor Rutherford is making an extended investigation into the properties of the Alpha stream of particles emitted in many of the stages of disintegration of radium. A preliminary account appears in the *Philosophical Magazine* for July. The main object of the experiments is to obtain a more accurate measure of the mass of each of these particles, and thence to decide whether or not they are identical with helium. This better value has not yet been obtained, but many facts of importance have turned up in the course of the preliminary observations.

Previous measurements have been made on the particles shot out from radium. But it is now known that radium in a state of radio-active equilibrium is a very complex substance; and that the particles shot out at different stages do not leave with the same velocity. The improvement now introduced is to use one of the disintegration products alone, viz., Radium C. Radium A (the product of the disintegration of the emanation) is deposited on a highly negatively charged wire. This quickly breaks up successively into Radium B and C, and the Alpha particles then shot out are taken as arising from C because B does not emit any. This wire is then placed behind a slit, and the stream that passes the slit falls on a photographic plate, slit and plate being placed a few centimetres apart. The whole is placed in a transverse magnetic field in a vacuum, and the field reversed every ten minutes for about an hour. On development the plate shows

two narrow bands, at greatest 4·7 mms. apart, and from this measurement the curvature of the stream due to the field was determined. From this the value of mass × by velocity ÷ charge of each particle can be calculated. The values obtained are much more definite than previous ones. To complete the calculation of the mass, it is necessary to deflect the stream by an electrical field as well. This has not yet been done, owing to the difficulty of quickly obtaining a sufficiently high vacuum.

If thin aluminium sheets are interposed the velocity of the stream is reduced; and experiment shows that the photographic action ceases when the velocity is still 64 per cent. of its initial value—*i.e.*, when the velocity is about one-twentieth that of light. The ionising and phosphorescent action also cease at this velocity. This is a surprising result, for the particle still possesses nearly 40 per cent. of its initial energy at this stage.

The similarity in respect to the three phenomena can be most simply explained by supposing that photographic action and phosphorence are essentially due to ionisation.

It is most interesting to observe that the actual velocity of emission is on the average only about 30 per cent. greater than this critical velocity. The Alpha stream would not have been detected if its velocity had been much less than it is. Professor Rutherford points out that disintegration may be taking place in other substances and be practically undetectable, because this lower limit of ionising velocity is not attained by the particles emitted. This remark may also apply to Radium B, which is a so-called *rayless* product; and we further suggest that a similar remark may apply also to the Beta particles, and that such slow velocity negative particles may therefore be present *in each of the stages of disintegration*. This supposition would remove the difficulty which some feel in conceiving of the production of a positive particle without a negative one being simultaneously generated.

ZOOLOGICAL.

By R. LYDEKKER.

The Late Dr. W. T. Blanford.

ZOOLOGISTS and geologists throughout the world will hear with unfeigned regret of the death of Dr. William Thomas Blanford, C.I.E., F.R.S., which took place at his residence in Campden Hill, London, on June 23, after a brief illness, in his 73rd year. Dr. Blanford was on the staff of the Geological Survey of India from 1855 till 1882, retiring with the rank of Senior Deputy Superintendent. He was a gold medallist of the Royal Society and a Wollaston Medallist of the Geological Society, and had been President of the latter body as well as of the Asiatic Society of Bengal. During his Indian service he was attached as naturalist to the Abyssinian Expedition under Lord Napier, and later to the Persian Boundary Commission under Sir F. Goldsmid. Of late years he had devoted himself largely to the study of the geographical distribution of animals and of the changes in the configuration of the earth's surface which have had so much to do with the same. Among his important works may be mentioned the "Zoology and Geology of Abyssinia," the "Zoology and Geology of Eastern Persia," the "Manual of the Geology of India," written in collaboration with the late Mr. H. B. Medlicott; the Mammalia and the Geology of the Second Yarkand Expedition, and the volume on Mammals and two of those on Birds in the "Fauna of British India," of which series he was the editor.

The Origin of Salamanders.

At the conclusion of an elaborate memoir on the development of the vascular and respiratory systems of the Australian lung-fish (*Ceratodus forsteri*), published by the New York Academy (Mem. II., part 4), the author, Mr. W. E. Kellicott, remarks that the main object of his investigation was to obtain evidence with regard to the relationship of the lung-fishes, or Dipnoi, to other groups. "It is impossible to believe," he observes, "that the Amphibian resemblances seen in *Ceratodus* in the development of the vascular, respiratory, and urinogenital systems, as well as throughout the earlier processes of development, are in the nature of parallelisms. In the light of their embryology it is impossible to believe that the Dipnoi and the Amphibia are not closely related, and that they have not travelled for a time along the same path at some period during their history." If this view is to be accepted, we must apparently regard the early lung-fishes as the direct ancestors of the extinct primeval salamanders, or labyrinthodonts. A further inference would seem to be that the gills of modern salamanders (which in certain kinds are retained throughout life) are directly inherited from fishes, and not, as has been suggested by some, a new and independent development.

A New Group of Extinct Reptiles.

In a recent issue of the *Memoirs* of the California Academy of Sciences (Vol V., No. 1) Mr. J. C. Merriam describes a group of extinct marine reptiles from the Triassic (Upper New Red Sandstone) deposits of California, which he regards as representing a new order, the Thalattosauria, typified by the genus *Thalattosaurus*. In many respects these reptiles resembled the ichthyosaurs, or fish-lizards, having the eye similarly furnished with a ring of bony plates. They are, however, broadly distinguished by the upper temporal region of the skull, which has an upper and a lower bony arch, and likewise by the character of the dentition, which takes the form of flattened, crushing teeth, some of which are situated on the palatine and vomerine bones. From these and other features the thalattosaurians appear to be most nearly allied to the rhynchocephalians, as represented at the present day by the New Zealand tuatera (*Sphenodon*), to which they appear to present the same kind of relationship as is borne by the extinct sea-serpents (Pythonomorpha) to the lizards. If this be so the Thalattosauria might perhaps be best regarded as a sub-order of Rhynchocephalia. Be this as it may, the special interest attaching to the group is the evidence it affords of the independent adaptation of yet another type of reptile to the exigencies of a marine existence, and this, too, at an early period of the earth's history.

The Origin of Mammals.

In a paper communicated to the March issue of the *Zoologischer Anzeiger*, Dr. Sixta, of Bohemia, discussed the evidence at present available with regard to the ancestry of mammals and fully endorses the view of those who hold that the group is directly descended from reptiles, and has no near kinship with amphibians. As regards the earlier stages of development, Dr. Sixta points out that the Australian duck-bill, or platypus, on the one hand and reptiles on the other are intimately related; the resemblance, in all stages of development, being most significant when the duck-bill is compared with the chelenian group (turtles and tortoises). The chief features in this resemblance were, according to Dr. Sixta, noticed independently by himself and by Dr. Hill, of Sydney, as the result of different modes of investigation, and may therefore be regarded as well-founded. That reptiles were the direct ancesters of mammals is now, in the author's opinion, an ascertained fact.

Papers Read.

At the meeting of the Zoological Society, on May 16, Mr. O. Thomas described a new South African golden mole. Mr. F. E. Beddard contributed a paper on the cranial arterial system of birds and reptiles. Sir H. H. Johnston criticised Mr. Rothschild's views with regard to the classification of man-like apes, while Mr. K. Andersen discussed certain kinds of horse-shoe bats. On behalf of Dr. E. Bergroth, a communication was read on the stridulating organs of certain hemipterous insects. Dr. P. C. Mitchell discussed the anatomy of the Limicolina birds, and Mr. R. I. Pocock redescribed the Hainan gibbon. At the final meeting of the session on June 6, Col. C. Delmé-Radcliffe gave an illustrated account of the natural history of West Uganda. Mr. M. Jacoby described new forms of *Œdionychis*. Dr. Mitchell discussed the mammalian intestinal tract. Dr. H. Gadow read a paper on the distribution of Mexican amphibians and reptiles. Mr. G. A. Boulenger described new reptiles collected by Dr. Gadow, and also new reptiles and amphibians from South Africa. Mr. Beddard referred to features in the anatomy of certain lizards. Mr. R. Assheton reported on the development of the spiny mouse. The Rev. S. Gorham described new South African beetles, and Baron F. Nopcsa discussed the position of one of the bones in the skeleton of Diplodocus.

REVIEWS OF BOOKS.

The New Knowledge, by Robert Kennedy Duncan (Hodder and Stoughton; price 6s. net).—Let nobody be discouraged by the title of "The New Knowledge" which Robert Kennedy Duncan has given to a volume which sets out, in language which is plain-spoken and easily understood, a good many of the new views in chemistry and physics that the lately imagined anatomy of the atom has created. Let them also, while reading his preface, forgive him for the expression that "in science when a new Alaska is discovered there is a rush of tenderfeet to the district"—for the sake of the germ of truth it contains. What Professor Duncan means is that when an attractive theory is started, such as that the line between force and matter is indiscoverable and perhaps does not exist, there are hosts of raw speculators, who, having been at no pains to arrive at this theory by the slow process of ascertained facts, make up for their lack of knowledge or industry by windy forecasts of what may possibly turn out to be true. Such, for example, are the immature students who announce that in radium's activity lie the germs of life. Professor Duncan's method is not this. He wishes clearly to set out without speculation, without surmise, and as simply as possible, the new conceptions of matter, and to show how they are related to one another, and how they are mutually interdependent. He considers, therefore, the later ideas concerning the implied meanings of the terms Matter, Energy, and Ether; and the consequent importance of the symbols, atom and molecule. Thence he shows how the Periodic Law, governing the structure of the elements which atoms build, took a further step along the road of theory; and, after that, how the theory of the travelling corpuscle, the "ion" of a gas, arose. The relation of the corpuscle, and the force with which the corpuscle is charged, lead up to the confirmation by solids of the laws suspected as existing in gases. Finally, the re-determination of these facts by the observed phenomena of radio-activity is considered, and the reasons for formulating an electric theory of matter, and for regarding the atom as a planetary system of ions or forces, are shown. Professor Duncan has brought together a number of modern theories; he has considered them not critically perhaps, but logically; and he has shown how they are related to one another. His volume is one which can confidently be recommended to that vast army of inquirers who, not themselves being scientific students of physics, are yet possessed of trained intelligence, and who want a good book on the whole subject.

A Manual of Quaternions, by Charles Jasper Joly, D.Sc., F.R.S. (Macmillan; price 10s.).—Professor Joly modestly describes his volume on Quaternions as introductory to the works of Hamilton, the great expositor of a new mathematical method; but it is a great deal more than that. It is a digest of the works of Hamilton, of Tait, and of other mathematical essayists in this subject; it embraces many results which have appeared in the publications of learned societies, and many others which are new; and so is to be regarded rather as a definition of the uses, the applicability, and the possibilities of Quaternions in mathematical usage as at present understood. This view, however, of Professor Joly's work is not exhaustive, for it does more than gather the theories and expositions of Quaternions under one roof; it is, if not a royal road, then, at any rate, a very carefully constructed road along which to approach them, and one which no other writer has attempted to provide. The works of Hamilton do not aim at teaching the uses of Quaternions; they rather exhibit the implications, the consequences, and the hypotheses of the symbols; the student may be imagined as panting after Hamilton up mathematical heights in order to attain comprehension and power. Professor Joly's method is not the same. He exhibits the properties of the Quaternion early in his treatise; he takes the student blindfolded along one defile, and he cuts steps in which he may place his feet. The readers of this notice must pardon a slight exuberance of metaphor; our final intention is to say that Professor Joly has written a book on Quaternions which will be invaluable to the student. It exhibits the practical uses of the Quaternion in working out mathematical problems; its own methods are developed with admirably patient clearness; and it is introductory to the works of Hamilton in the sense that study of it will open up fields of mathematical inquiry which hitherto have been worked by the few rather than by the many.

The Evolution of the World and of Man, by George E. Boxall (London: Fisher Unwin, 1905).—This may very justly be called a book of nonsense. It has fallen to our lot to have to read many stupid or indifferent books on the evolution theory, but a more pitiful muddle of fact and fiction than is to be found within the two covers of this volume has, we venture to say, never before been offered to a long-suffering public.

The author assures us that this work was undertaken "not so much for the advancement of science . . . as for the benefit of the man in the street—that is to say, the common people"! We shall be surprised if "the man in the street" does not show discrimination enough to leave this pretentious guide to knowledge severely alone, though, as a rule, we must sorrowfully admit "the common people" are but too ready to read stuff of this kind. In like manner they run after patent medicines, patent foods, faith healers, and other quackery.

By way of a sample of what is offered for the consumption of "the common people," we give one or two illustrations. Thus, "For the production of young" we are told "the female supplies the protoplasmic base in the shape of a seed or an egg, which is fertilized by the male introducing into it matter containing the necessary life germs!!" Again, "But the change of form from one order to another—as from univalve crustaceæ to bivalve, from these to the articulated shell-fish, or from these to the vertebrates—marks an era in evolution"!!! Man we are told has been evolved from a creature closely resembling the marsupial Koala, which, for want of a better name, he calls "the Menschensvorgänger, or Menschensvorfahrer, the progenitor, ancestor, or precursor of man"!! Shades of Darwin and Huxley, what are we coming to?

But why go on? We have surely said enough to show that no words of condemnation can be too strong for this jumble of silliness. W.P.P.

Some Elements of the Universe Hitherto Unexplained, part I., by A. Balding (King, Sell, and Olding; price 1s. 6d.).—Presumably this book would not have been written had the author fully grasped the significance of "relative motion," "instantaneous eclipse," and other well-known ideas. Before reaching Chapter I. we find a list of definitions, some of which might have emanated from a Junior Science Form, *e.g.*, "Quadrature —A quarter of the heavens or a point intermediate between directly opposite parts of the sky." This is discouraging and tends to render us more critical. Some of the statements are not so clear as the above sample. The author proceeds to account for the conservation of energy in the solar system by the motion of that system in space, and insists on dealing with "real paths." This is tantamount to finding all motor-cars guilty of "contravening the Act" by travelling (many of them backwards, sideways, or even vertically) at a speed never less than 20,000 miles an hour. The motion of Halley's comet and of the earth are treated in this unnecessarily complicated manner, and then the author falls foul of the accepted explanation of the Equation of Time, said to be due partly to the eccentricity and partly to the obliquity of the earth's orbit. The first part is confessedly inadequate by itself; the second, says our author, *does not exist*. How would he deal with an obliquity of 90°? Again, though it is obvious the solar day must be longer when the earth is moving faster in its orbit, he professes to find this an enormous difficulty only to be explained from his new point of view. His simple derivation of a new value, 234°, for the longitude of the solar apex, from the radiants of meteors, is unfortunately quite unsound, as the meteors are not independent of the solar system, even if we grant the accuracy of a mysterious table of "true radiants."

Our Stellar Universe: A Road Book to the Stars, by T. E. Heath (King, Sell, and Olding, Ltd., 1905; pp. 74; 5s. net).—The author has introduced a most interesting scheme of presenting the members of the stellar universe to the popular as well as the general scientific reader. The general impression after reading many astronomical treatises is that the stars are so far removed that the only possible conception of them is as if they were lying on the surface of a sphere, all at practically the same distance. The present book is to show that, with the most recent and authentic values of stellar parallax, it is conceivable to picture many members of the stellar universe as situated at various distances from the Sun. Not only this, but

it may be that a more correct idea of the relative importance of the various bodies can be thus obtained. The unit on which all the measurements are made is the light-year, and there is a fortunate coincidence in the fact that *if the distance which light travels in one year be represented by one mile, then the distance of the earth from the Sun will be represented by one inch on the same scale.* Based on this idea, a series of maps are presented, showing the positions of the members of our solar system, all stars within the distance of 60 light-years, and those within 430 light-years. These are compared with known terrestrial distances in order to fix ideas. Next an endeavour is made to present a stereoscopic chart of the stars, the size of the relative images being made proportional to their *sun-power*. The distance between the two images is taken as 107 light-years, and the distances plotted according to the best determined parallaxes. The stereograms given are very interesting, but, beyond giving a concrete illustration of the effect of parallax, cannot be considered as showing the actual distribution of stars in space. An appendix contains useful lists of stellar magnitudes, spectral types, and parallax values.

Our Stellar Universe, by T. E. Heath (King, Sell, and Olding, Ltd., 1905; 3s. net).—This little volume contains six stereograms of the sun and surrounding stars, and is intended as a companion to the author's larger work above mentioned. An index of all the objects shown on each chart is included, with the individual magnitudes, comparative sun-power, and spectral type.

The Hand Camera and What to do With it, by W. L. F. Wastell and R. Child Bayley (Iliffe and Sons; price 1s. net).—The photographic possibilities, and the principles that underlie them, in the use of hand cameras is a very large subject. But practical work of the kind that has come to be known as "snap-shotting" is so simple that those who indulge in it are apt to underrate the value of a general knowledge of the facts that their results depend on. All such, as well as beginners in the art, will reap considerable advantage without much intellectual effort by reading this volume. The authors deal with the purchase of a camera, the several types of cameras and their various parts, the manner of their use, the development of the negatives, and the preparation of prints and enlargements from them. The information given is practical and reliable and well selected. The volume takes the place of one written a considerable time since by Mr. Welford, and perhaps this accounts for the inclusion of the "uniform system" of marking lens diaphragms, which was never widely adopted, and was officially withdrawn many years ago by the Royal Photographic Society, who were responsible for its introduction. Half-a-dozen good reproductions of hand-camera pictures are given, four of which are of architectural subjects, and serve to show the use of the method in a sphere that too many regard as altogether outside its scope.

The Nature of Explosions in Gases. H. B. Dixon, F.R.S. (Henry Frowde; 1s. 3d. net).—This is the tenth Boyle lecture, delivered before the Oxford University Junior Scientific Club, and deals in particular with the mode in which flame is propagated in explosions and the nature of the chemical reactions occurring. Reference is made to the fact that it was while repeating Bunsen's work that he discovered that a dried mixture of carbonic oxide and oxygen would not explode under the action of a spark which readily kindled the moist mixture. The main part of this lecture is concerned, however, with the *rate* of explosion. Berthelot showed this rapidly increases from its point of origin until it reaches a maximum which remains constant however long the column of gases may be. Mr. Dixon considers that the wave must be propagated not only by the burnt but equally by the unburnt molecules (with which the former exchange velocities), and that therefore half the unburnt molecules are heated by the collision before they are burnt. He finds an extraordinary close agreement between the rate calculated from this point of view and the actually observed rates. Some photographs of compression waves through heated gases are reproduced and discussed.

We have received **Electricity** No. 21, Vol. XIX; and **The Indian Electrical and Mechanical Textile News**, No. 8, Vol. II. (Bombay), containing amongst articles of interest on electrical and other topics a capital portrait of Sir Joseph Wilson Swan, F.R.S.

Suggestions Towards a Theory of Electricity Based on the Bubble Atom. John Fraser. This is a reprint from the Proceedings of the Royal Society of Edinburgh. It is very difficult to appraise the theory which is here presented, because the author is not very clear in the way that he brings it forward. It is obviously highly original, although it bears certain resemblances to Osborne Reynolds' theory of matter. On both theories matter is supposed to be represented by gaps in the ether. On Mr. Fraser's theory the ether is prevented from falling into these gaps by the rapid motion of the particles forming the surface of the gap. We cannot follow the author into his applications of his theory to the elucidation of the electrical properties of bodies. But we must remind him that a tremendous quantity of experimental facts are now known, and any theory which hopes for a long life must be capable not only of explaining these but also of keeping step with the rapid progress of discovery. If Mr. Fraser will find some friend more skilled in the art of advocacy than he seems himself to be, it is possible that the numerical correspondences which he displays in a table at the end may be shown to have a great value in guiding theoretical physicists to a correct view of the constitution of matter.

Practical Gum-Bichromate, by J. Cruwys Richards (Iliffe and Sons; price 2s. 6d. net).—This process, which has lately been in great favour with those who like to alter their photographic results to suit their taste, is here described by a practised hand. The directions are so plain and straightforward that anyone may follow them; but, of course, the worker's success, from a pictorial point of view, must depend upon his skill and artistic knowledge, for this alone can guide him in the "local treatment," and the putting in of "bright specks" by means of "the point of a penknife, or a dry brush, or anything else that experience may dictate." The author has given his own methods of work and his own preferences; but he has added the formulæ for coating the paper as used by several other well-known and successful workers of the process. The illustrations are excellent guides to the appearance of prints at various stages of their production, especially in the multiple printing methods.

Unbeaten Tracks in Japan, by Isabella L. Bird (Mrs. Bishop) (London: John Murray, 1905 (Popular Edition); 2s. 6d.).—In issuing a cheaper and popular edition of this charming volume we venture to think some intimation should have been given to the effect that this book is concerned with Japan as it was some seven-and-twenty years ago. It would also have added much to the convenience of the reader if the full dates of the several letters, which make up the chapters of this work, had been added. Only here and there do we get anything nearer than "May 30" or "August 24." The first letter appears to have been written on May 21, 1878, the last on December 18 of the same year.

We suspect that the horrible neglect of sanitation so vividly described by Mrs. Bishop is to-day, for the most part, a thing of the past, even in the out-of-the-way regions described. Certainly we hope that the unspeakable cruelty which appears to have been practised on horses has long since ceased.

This book is too well known to need a long description. In its new and most attractive form it should gain a large number of fresh readers.

Wasps Social and Solitary, by George W. Peckham and Elizabeth G. Peckham (A. Constable and Co.; price 6s. net).—It is difficult for the casual reader to ascertain the exact object of this book, and whether it is intended for the nursery, schoolroom, or as a scientific treatise. The plain and childlike language and the simple and, we may say, unscientific methods of observation described would lead one to suppose its object was to instil into the juvenile mind an interest in natural history. Yet there is something more than this in the book. The careful observations noted and recorded have their value to the student, and the habits of some species of wasps are well worth noting and recording. The detailed account, for instance, of an Ammophila making its nest in the ground, filling up the hole, and then pounding in the grains of sand by means of a small pebble held in its mandibles, is certainly most interesting. The illustrations are by James H. Emerton, whose age is not given, but we should doubt whether his talents, when he grows up, would qualify him for Academic honours.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The Action of Hydrogen Peroxide on Photographic Plates.—Dr. Chiri Otsuki has made a communication (Jour. Soc. Chem. Ind., 1905, p. 575) on this subject, in which he confirms many of the results obtained by Dr. Russell some years ago. What seems to me the most important detail in this communication, though the author appears to regard it as of very little importance indeed, is the statement that a plate that had been acted on by hydrogen peroxide and that would have given an image by development, partly lost the possibility of development by "laying the photographic plate for eleven minutes in water," and that "after leaving it one hour in water after the exposure no picture of the hole was obtained." It seems that Dr. Otsuki's only conclusion from this is that the developable possibility is due to something (hydrogen peroxide) condensed on it, and that may be washed off or out of it. But developable silver bromide cannot be watered back into the undevelopable variety. If the peroxide can be washed away and leave the plate unaffected, then it does not produce the developable condition at all, but merely co-operates with the developer, in the absence of light, to reduce the silver bromide to the metallic state. Or it may be that the developable condition produced by a form of radiant energy emanating from the peroxide is destroyed by the soaking in a weak solution of the peroxide, though this latter explanation appears hardly tenable in face of the fact that Dr. Luppo-Cramer in his experiments immersed the plates in solutions of hydrogen peroxide. In any case this possibility of washing away the peroxide, and with it any effect that it may have produced, is of the greatest importance, if it can be confirmed. Theories ought to count for very little while facts are in doubt, therefore I do not think it worth while to refer to those put forward by Dr. Otsuki, especially as they appear to me to be founded on many false assumptions. I still think that some of the results obtained by Dr. Russell and those who have followed him cannot be explained on the simple vaporization theory, and I see no reason to qualify the remarks I made on these experiments seven years ago, and in the last January and February numbers of this journal.

The Spectrum as a Photographic Test.—It is difficult for the person who has not been scientifically trained to appreciate the statement that the spectrum is, and must be, the only final test object in all experiments concerning colour sensitiveness, colour reproduction, and the like. It seems to be a common idea that scientific instruments can be used and the results they give interpreted by anyone who can use the instruments in the sense in which one uses a tourist's telescope. Of course, this is a grave error, but it accounts in large measure for the ideas held by many that spectrum tests are deceptive, that as spectra "do not grow on trees" they are not suitable objects to work with in seeking for methods of photographing Nature, and that a process may be right spectroscopically but not right when tested with pigment colours. The expression "the spectrum," that one is forced by custom to employ, is deceptive, for it often conveys the impression that there is a spectrum or some particular spectrum that is the standard spectrum, and so hides from the merely practical mind the fact that spectra are as numerous as lights—indeed, may be far more numerous, and that in dealing with a spectrum one has the given light simplified by being separated into its component parts. But this very simplification when unwisely done may be a source of confusion and error, as if one in seeking for the beauties of language in a piece of writing were to dwell unduely upon the etymology and the spelling of the words.

A spectroscope is really a very dangerous guide in the hands of those who do not thoroughly understand it; it is too often like a micrometer in the hands of a tailor, unnecessary, troublesome, and misleading. Those who have not made a special study of its use should have but little to do with it; they should rely upon a judicious selection of pigments or coloured glasses. With these a great deal can be done; perhaps, indeed, all that is necessary for practical purposes. But at the same time, final and inclusive work can be done only spectroscopically, and only by one who is really expert in the use of the instrument for the particular purpose required.

For ordinary photographic purposes in connection with colour, I think that the chief difficulties peculiar to this kind of work result from the unequal dispersion given by prisms, the employment of a too small or too large dispersion, and the giving of unwise exposures. It is generally desirable to give a series of exposures in geometrical ratio, and it may be necessary to reduce with a coloured screen the light that is most active. Of course, there are many other experimental difficulties which are common to all spectroscopic work, and others common to all photographic work.

Oxidation of Sodium Sulphite Solutions.—The oxidation of sodium sulphite by exposure to the air takes place far less readily than is often supposed. The efflorescence on the crystals has been taken by many chemists as evidence of the presence of sodium sulphate, whereas it is due merely to the loss of water of crystallization. Solutions of the salt are also stable if preserved with common care. Messrs. Lumière and Seyewetz have recently observed that they are even less liable to oxidation if a small quantity of a developer is added, and they give the following list, placing the substances in order of their effectiveness. Hydroquinone is the best; then follow, paraamidophenol (the active agent of "rodinal"), glycin, paraphenylene-diamine, catechol, metol, "metoquinone," amidol, adurol, edinol, and eikonogen. The addition of alkalies or their substitutes, such as acetone or formaldehyde, diminishes the preservative action. Hence the idea that a one-solution developer, especially if made with hydroquinone and also in the case of "rodinal," is peculiarly free from liability to spoil by exposure, seems to be founded on fact.

Competition.—The Thornton-Pickard Manufacturing Co., of Altrincham, are offering several series of cash prizes for photographs taken under conditions that will be sent on application. The entries must be received before October 1.

The Potentia Organization.

An international organization is being formed by a number of influential representative men to establish amongst nations a mutual relationship and co-operation for the diffusion of accurate information on events effecting the peace of the world Sir Vincent Caillard, Professor G. H. Darwin, and Sir Michael Foster are the English representatives.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Royal Microscopical Society.

June 21st, at 20, Hanover Square, G. C. Karop, Esq., M.R.C.S., Vice-President, in the chair.—Three old microscopes were presented to the Society's collection by Mr. C. L. Curties. A noteworthy donation to the Library was the concluding part of Dr. Braithwaite's "British Moss Flora," the publication of which extended over 25 years. Dr. Lazarus-Barlow exhibited and described a new form of warm stage, devised by him, which could be heated by oil or gas. The regulation depended upon the expansion and contraction of a fixed volume of air, acting through a manometer upon a delicately-balanced lever, at one end of which a silver rod was carried in a horizontal position, the flame being applied to one end of the silver rod, while the other end, which was bent downwards, dipped into a paraffin bath attached to the side of the stage. As the temperature of the stage increased, the contained air expanded, and acting on the manometer caused the lever to raise the silver rod and so to practically withdraw the bent portion from the paraffin bath. Mr. C. R. C. Lyster also exhibited an improved form of warm stage, heated by electricity. Such warm stages are generally heated by resistance coils, but the variations in the intensity of the ordinary house current render the temperature variable, but Mr. Lyster found he could maintain a perfectly even temperature by using cryptol as a resistance, whilst the amount of current did not exceed 150 milampères. Mr. C. L. Curties exhibited an arrangement for obtaining dark ground illumination with high powers by a stop over the objective, which was suggested to him by a contrivance of Leitz. Mr. Curties observed that only in certain cases were the images of the markings on diatoms shown by this means to be considered as trustworthy evidence of their real structures. Mr. Rheinberg called attention to an experiment, showing that the appearance of a grating could be produced in the field of the microscope without there being anything on the stage. The lines seen were achromatic interference bands, produced with the help of two of Thorp's gratings of equal pitch placed behind the objective. Mr. Rousselet called attention to a living specimen of *Plumatella punctata (Hancock)*, sent by Mr. Hood, of Dundee, which has apparently not been recorded in England since its discovery by Hancock in 1850. It differs from other species of *Plumatella*, mainly in having a soft, transparent ectocyst. Mr. Nelson communicated a note on the Tubercle Bacillus, and Mr. A. E. Conrady gave a *résumé* of his second paper on "Theories of Microscopic Vision." The proceedings concluded with an exhibition of fine zoological lantern slides, lent by Mr. A. Flatters.

The Quekett Microscopical Club.

The 423rd ordinary meeting was held on June 16th, at 20, Hanover Square, W., the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the chair.

Mr. W. Wesché, F.R.M.S., gave an abstract of his paper on "The Genitalia of *Glossina palpalis*," the Tsetse fly, the host of the "sleeping sickness" organism. This was shown to be homologous with certain other flies, though differing in the presence of a double lever at the extremity of the central organ, a feature which also occurs in the cockroach.

Mr. Julius Rheinberg, F.R.M.S., showed an experiment on the production of achromatic interference bands in a new manner, which formed the subject of a paper which he had recently read at the Optical Convention. Certain experiments in connection with the theory of microscopic vision had led to the curious result in question, which amounted in effect to producing in the microscope, on the object stage of which a piece of paper having a large perforation had been placed, the appearance as if a grating had been placed over it, the lines appearing perfectly sharp in black and white.

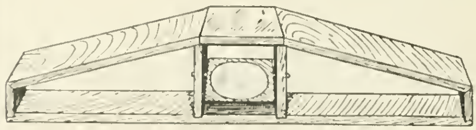
Mr. Rheinberg gave a description of the manner in which this striking interference image was produced.

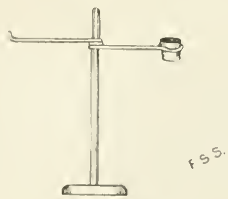
Mr. Wesché then gave a popular lecture on "Pond Life," which he hoped would encourage any novices who might be present to take up this fascinating branch of microscopy. It was illustrated by a number of lantern slides prepared from Mr. Wesché's drawings and designed to show the objects under dark ground illumination.

The next general meeting of the Club will be on October 20th, but the usual fortnightly meetings will be held during the vacation for gossip and exhibition of objects. There are also several excursions during the summer months to various collecting grounds. Visitors will be welcomed to both meetings and excursions, and may obtain full particulars on application to the Hon. Secretary, Mr. A. Earland, 31, Denmark Street, Watford.

Home-Made Dissecting Stand.

I have been several times asked to recommend a dissecting stand, and though for convenience the stands made by Zeiss, Leitz, and Reichert in various patterns cannot well be improved upon, still the cheapest of them costs, with two lenses, a couple of sovereigns, and





it may interest many of my readers if I describe here a stand which can be made at home by anyone who can do a little carpentering and which need cost only a few shillings. A reference to the accompanying drawings is almost self-explanatory. The total length of the stand should be about 14 inches, and the width about

four inches. The sloping rests for the hands might be about two inches high at the lowest ends and four inches at the highest, but these measurements should be governed by the size of the mirror, which must have ample room in which to swing. The mirror itself is a simple round penny mirror, such as can be bought at almost any toy shop, the larger the better. It is deprived of its metal cover and let into a piece of wood, which swings on wooden or metal pivots between the two centre uprights of the stand. The simplest way in which to make the support for the mirror is to carefully cut a hole of the proper size in a piece of stout fret-wood, and to back it with another piece of fret-wood, glueing the two together and mounting them on a cross beam, the projecting ends of which are carefully shaped circular and fit fairly tightly into corresponding holes. This piece of wood could also be hinged to the bottom of the stand, but in that case the mirror would not remain central when tilted at an angle. A little more skill would be required to arrange universal movements, but they are really not necessary. The stage is a piece of plate glass, 5 by 4 inches, ground at the edges, and can be ordered from any glass shop for a shilling or so. It lifts out if necessary. Two pieces of cardboard of the same size should be cut to go underneath when required; both should be covered on one side with black and the other side with white paper, and one should have a hole about 1½ inches in diameter in the centre. The whole stand might be made of wood ⅜ inch thick, mahogany or walnut being preferable to pine, and the dove-tailing or grooving should be done and finished off as carefully as possible.

The holder for the lenses can be made, as illustrated, by fitting a piece of ¼-inch brass tube about eight inches high into a small stand about 2½ or three inches in diameter. A piece of springy ⅛-inch brass wire is then rolled several times round the upright, as shown; one end is turned up about three inches away from the stand, and the other end is shaped into a ring to hold a watchmaker's eye-glass. This last can be bought anywhere for about 10d. or a 1s., and makes a most useful dissecting lens. On the turned-up end can be put an ordinary pocket magnifier in ebonite mount, such as can be bought for a shilling and upwards, according to the number of lenses.

This stand, simple as it is, will be found a useful and efficient piece of apparatus. It will be money well spent if the worker provides himself, however, with one of the beautiful aplanatic lenses sold by all the principal opticians. They give exquisite definition, together with a flat field, and being much less tiring to the eyes are excellent for dissecting, and are also the most perfect of those magnifiers which the real microscopist can always bring forth from his pocket when wanted. The most useful powers do not exceed ten diameters, and a lower power gives a larger field and greater working distance. Perhaps six is the most useful and convenient magnification.

Botanical Microscopical Slides.

Mr. A. Peniston, of 5, Montpelier Terrace, Leeds, has sent me a catalogue of botanical slides which contains a novel feature in that it not only gives the principal features of the slides referred to, but in many cases adds outline descriptive illustrations. Many of the slides are also quite out of the ordinary run, amongst which I observe a slide of œdogonium, showing oogonia and so-called "dwarf males," early stages in the development of antheridia, developing pollen-tubes, etc. The prices are very moderate and the whole list shows evidence of having been the work of a botanist and not a mere mounter.

Answers to Correspondents.

O. H. Sargent, York, W. Australia.—I am afraid that the difficulty to which you refer is, as you suggest, inherent in deep eyepieces when used with ordinary achromatics. Few of such objections will satisfactorily bear eyepiecing above 10 times, and even then the loss of light and depreciation of the image is noticeable. If your eyepiece is capped, it is just possible that this is not correctly adjusted. Possibly also you are using a larger cone of illumination than your objective will stand. Few objectives will bear a cone equal to their own aperture and a two-thirds or three-quarter cone is generally ample. You can judge of the size by removing the eyepiece and looking down the tube. All camerae lucidae require considerable practice before satisfactory results are obtained. You would probably find the Swift-Ives type as easy to use as the Abbe, but it too requires practice. The great secret is the careful adjustment of the light, and I think the best way is to have two lamps, one to illuminate the object in the microscope and one to illuminate the paper on which you are drawing. The flames of each lamp can then be carefully adjusted, until the brightness of the microscope field does not overpower the illumination of the paper, or *vice versâ*. You will find very different adjustments are required for any change of magnification. I think you will find an ordinary twelfth immersion objective of N.A. 1·25 or so perfectly satisfactory, and there is very little to choose between those made by the leading makers. The cost will be £5. But all your objectives must be used with the tube-length for which they are corrected. As your eye becomes more trained you will perceive this yourself, especially for such critical work as cytology. The study of the pollination and fertilization of W. Australian plants ought to prove an almost inexhaustible field for work of all kinds if you work at it steadily and earnestly.

A. I. Robinson, Portsmouth.—I have had no experience myself in mounting diatoms in either carbon bisulphide or quinidine, and the nearest reference I can give you is a method by Mr. A. W. Griffin on mounting in solution of phosphorus in carbon bisulphide, which has a very high refractive index but needs great care. As a precaution against getting the phosphorus under the finger nails it is best to well oil or vaseline the hands. Procure some clean, semi-transparent phosphorus, cut off some pieces under water with a penknife, place them for a few seconds on blotting paper to free them from any least trace of water, and dissolve in carbon bisulphide, say, one drachm of phosphorus in two drachms of the solvent. When quite dissolved, slightly damp a piece of filter-paper with bisulphide, and carefully filter into a small stoppered bottle through a very small glass funnel. Support both funnel and filter paper in a basin of water to prevent accident, and have the basin handy throughout in order to place in it any article which has been touched by the phosphorus solution, in order to prevent accidental combustion. Supposing the diatoms are preserved in water or spirit, place a drop of the fluid on the cover-glass and slowly evaporate the medium over the flame of a spirit lamp or jet of gas. When the cover-glass is quite cool place on the margin of its edge a mere speck of Canada balsam, the object of which is to keep the cover, with its surface covered with diatoms, face downwards, in the centre of the glass slip. By means of a pipette take a few drops of the phosphorus solution and place them on the edge of the circle, and by capillary attraction they will be at once drawn under, displacing the air in their progress. Having ascertained that the diatoms are completely immersed in the medium, remove all superfluous particles of phosphorus with a piece of blotting paper damped with carbon bisulphide, and consign it also to the basin of water. Ring with glucine or Kay's coaguline, put aside to dry for six hours or more, ring again, and then, if preferred, ring finally with shellac, varnish or asphalt.

[*Communications and enquiries on Microscopical matters are invited and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for August.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.11, and sets at 6.49.

Sunspots are numerous; also recent spectroscopic observations of the Sun's limb have shown many bright and active prominences.

The position of the Sun's axis and equator, required for physical observations of the Sun, is indicated in the following table:—

Date.	Axis inclined from N. point.	Equator S. of Centre of disc.
July 30 ..	10° 6′ E.	5° 45′
Aug. 9 ..	13° 59′ E.	6° 24′
,, 19 ..	17 28′ E.	6° 53′
,, 29 ..	20° 28′ E.	7° 10′

An eclipse of the Sun takes place on the 30th; in this country it will be observable as a partial one; three-fourths of the diameter being obscured in the southern counties, diminishing to about one half in the Orkneys. From suitable positions in Canada, Spain, Algeria and Egypt the eclipse may be observed as a total one.

The particulars for London are as follows, whilst the diagram illustrates the appearance at maximum phase:—

At Greenwich, partial eclipse (Sun's diam. = 1), magnitude 0·786:

Begins	Aug. 30, 11 h.	49·1 m. a.m.
Greatest Phase ..	,, ,, 1	3·5 p.m.
Ends	,, ,, 2	15·1 p.m.

Eclipse as visible in London, 1.0 p.m. August 30.

THE MOON:—

Date.	Phases.	H. M.
Aug. 1 ..	● New Moon	4 3 a.m.
,, 7 ..	☽ First Quarter	10 17 p.m.
,, 15 ..	○ Full Moon	3 31 a.m.
,, 23 ..	☾ Last Quarter	6 10 a.m.
,, 30 ..	● New Moon	1 13 p.m.

A partial eclipse of the Moon takes place on the morning of the 15th. At Greenwich, however, the Moon sets before it is quite out of the shadow.

		h. m.
First Contact with the Penumbra,	Aug. 15	1 9·5 a.m.
,, ,, ,, Shadow,	,,	2 38·9 ,,
Middle of Eclipse	,,	3 41·0 ..
Last Contact with the Shadow	,,	4 43·1 ,,
,, ,, ,, Penumbra	,,	6 12·5 ,,
At Greenwich the Moon sets ..	,,	4 53 ,,

Magnitude of Eclipse (Moon's diameter = 1), 0·292.

Appearance of Moon at Middle of Eclipse, Aug. 15.

THE PLANETS.—Mercury, at the beginning of the month, is an evening star in Leo; he is at greatest easterly elongation on the 2nd, when he sets about one hour after the Sun. On the 30th, the day of the solar eclipse, the planet is in inferior conjunction with the Sun at 3 a.m., and at the time of the eclipse the planet is about 4° towards the S.W. of the Sun.

Venus is a morning star in Gemini, rising shortly after 1 a.m. throughout the month. On the 30th, the planet will be situated about 39° W. of the eclipsed Sun, where search should be made at the time of maximum phase, to ascertain if the planet is visible in the subdued light.

Eros is in opposition on the 7th, but being in the neighbourhood of its aphelion it is not a favourable opposition.

Mars is due south about 6 p.m. near the middle of the month, when he sets about 10 p.m. The planet is not well placed for observation, as he appears low down in the sky, and on account of increasing distance from the earth his lustre is diminishing.

Jupiter rises at 11.30 p.m. on the 1st and at 9.45 on the 31st. The planet is situated in Taurus, a little south of the Pleiades.

Saturn rises about 7.40 p.m. on the 15th, when he is on the meridian shortly after midnight. We are looking down on the northern surface of the ring which appears open at a smaller angle than of late years.

Uranus is on the meridian about 8.30 p.m. on the 15th. He is situated about 2½° south of the 4th magnitude star μ Sagittarii.

Neptune does not rise until after midnight.

METEORS:—

	α	δ	
Aug. 10-12	45°	+57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

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The Sun in Calcium Light.

By WILLIAM J. S. LOCKYER, M.A., PH.D., F.R.A.S.

II.

THE loaded plate-holder is next slid into its carrier, and both secondary slit and carrier are securely wrapped in velvet as is consistent with the necessary freedom of relative movement during the exposure. The window blinds in the room containing the instrument are then closed to keep out daylight as much as possible. By pushing the whole upper framework towards the east, the solar image is made to lie a little to the west of the primary slit. The length of exposure required is now judged by the brightness of the solar image, and the rate of movement adjusted according to a reading taken from a table giving the lengths of "runs" corresponding to the temperature of the oil. The dark slide is next opened and a suitable moment for exposure awaited. When this opportunity occurs the shutter behind the primary slit is opened and the framework released by a starting handle.

The primary slit then moves over the fixed solar image and simultaneously with it the secondary slit passes over the fixed photographic plate; the "K" image is thus built up in the form of a disc. The time of transit of the slit over the image is indexed as the "run," and when completed the slit shutter and plate are closed.

The operations for obtaining the photographs of the prominences round the limb are very similar to the above. The solar image falling on the primary slit is blocked out by means of a metal disc of the same size as this image, and a much longer exposure is given. The ratio of the length of a "disc" and "limb" exposure is about as 1 to 60. Under very favourable circumstances a "disc" exposure lasts about 15 seconds.

By taking a limb photograph first, and then removing the metal disc and making another "run" for the "disc," a composite picture on one plate is secured.

Since this spectroheliograph has only been working efficiently since the spring of last year (the recent winter months being excluded as the low altitude of the sun in London during this period renders this kind of work almost impossible), the data at present available for discussion are not very considerable.

It will, however, not be without interest to refer to some of the photographs obtained, which will serve to illustrate not only the quality of the negatives secured, but the different branches of work which such a series of photographs as previously mentioned open up.

In the accompanying illustrations will be found two enlarged reproductions, one of the solar disc in "K" light, taken on September 20, 1904 (Plate II.), and another of a composite picture showing the limb and disc taken on August 29 of the same year (Plate III.).

From a general examination of a great number of the "disc" negatives it has been noted that over the whole solar surface there is always a very distinct "mottling" extending even to the solar poles.

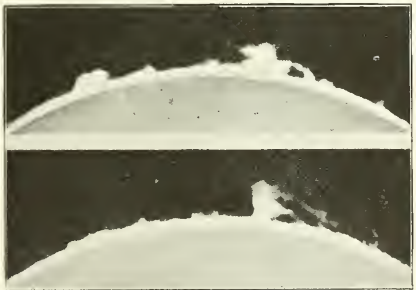

Fig. 4.—Illustrating a striking change in a prominence after an interval of one hour. July 14, 1904.

About the equatorial regions this mottling seems in places to be of an enlarged nature and unevenly distributed in longitude. In regions of apparently greater disturbance the bright portions of this mottling become amalgamated and produce the calcium clouds or "flocculi," as termed by Prof. Hale. The type of formation of these flocculi can be gathered from the illustration (Plate I., Fig. 2) given last month. A bright nucleus with radiating bright branches is not an uncommon feature in a great number of the plates examined.

It is in these larger flocculus regions that spots are observed. There can be flocculi without spots and flocculi with spots, but, so far as the photographs have shown, never spots without flocculi. The duration of a spot is, further, only a brief interval in the life history of a flocculus, so that to study the formation of spots their relation to flocculi must be taken into account. That an intimate connection in addition to that mentioned above does exist, is indicated by the fact that spots appear more generally to precede the apparent trailing masses of flocculi with respect to the solar

rotation. Some examples of these are shown in one of last month's illustrations (Plate I. Fig. 3).

These "K" line photographs of the disc of the sun will thus form the means of helping to solve many of the solar riddles. Several other equally interesting points to be investigated might be mentioned.

By photographing the solar limb and the disc on the same plate a means is afforded of noting the behaviour of prominences with reference to the flocculi. Thus it has been observed that although the "K" prominences near the solar poles are sometimes of very great dimensions, the mottling on the disc in these latitudes is always regular and apparently undisturbed. Again, a large prominence on the approaching limb of the sun in lower latitudes does not always herald the presence of a large flocculus region on the disc at the same position angle, neither does a flocculus passing round the limb necessarily indicate the position of a large prominence. In fact, it seems that although there may be some relation between prominences and flocculi, it is not a very close one so far as can be judged by the few photographs already discussed.

The spectroheliograph affords a very excellent means of studying the sequence of changes in the form of prominences. If the instrument be set up in low latitudes where the altitude of the sun is high at noon all the year round, and, consequently, the length of exposure necessary can be reduced to a minimum, a wealth of valuable information could be gleaned. In these latitudes, even in summer, opportunities are not very numerous owing to the frequency of cloudy days.

To illustrate the nature of such photographs one

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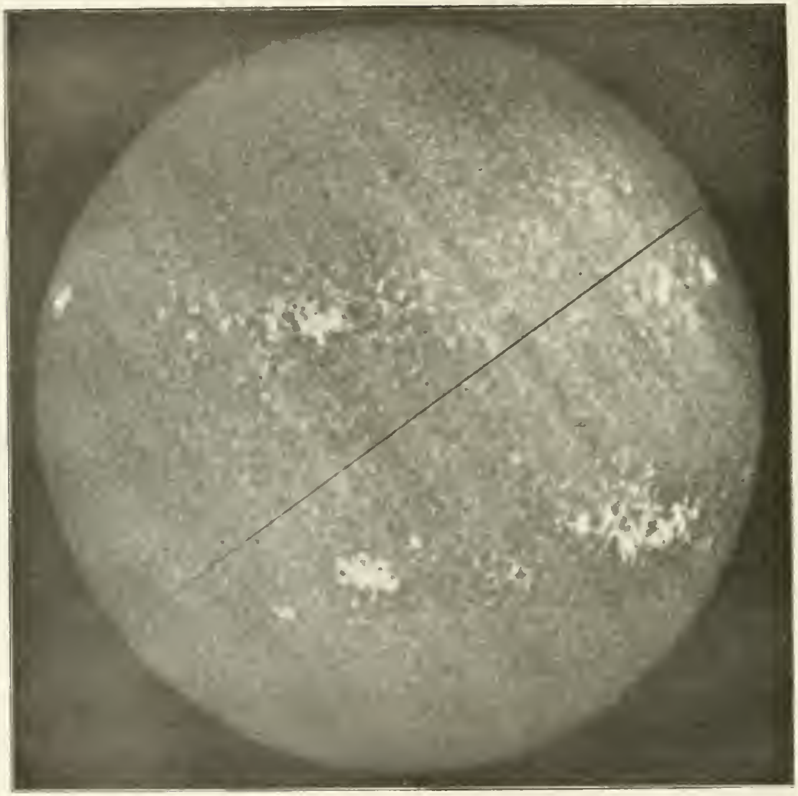

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PLATE II.—Sun's Disc Photographed in "K" (Calcium) Light. September 20, 1904.

Exposed from 10 h. 25 m. 0 s. to 10 h. 26 m. 10 s. (interval 70 sec.).

(Enlarged 2½ times.)

example is here given. This is shown in Fig. 4, and was secured on July 14 of last year, and the plates were exposed at 11h. 8m. a.m., and 12h. 8m. p.m. respectively. It will be seen that during this interval of about one hour a very decided change of form in the largest prominence has occurred. Instead of the somewhat symmetrical shape that existed at the first of these times the prominence is most intense on the left-hand side, and the material appears to be thrown towards the right as if acted upon by a strong current. Its height, at the same time, has been considerably increased. The other very intense but smaller prominence has almost disappeared during the same interval.

For very rapid changes of form in individual prominence, that is, changes that occupy only a few minutes of time, the visual method must still be employed, a most convenient form of instrument for this purpose being the Evershed form of spectroscope.

From the above somewhat cursory account of this spectroheliograph and its first fruits, it is hoped that some of our more wealthy readers will be induced to take up the work and carry out one or more of the numerous branches of this research which are as yet untouched. Although the initial expense is somewhat costly, the investigation of the sun by this instrument is so full of interest that the labour involved is sure to be well repaid.

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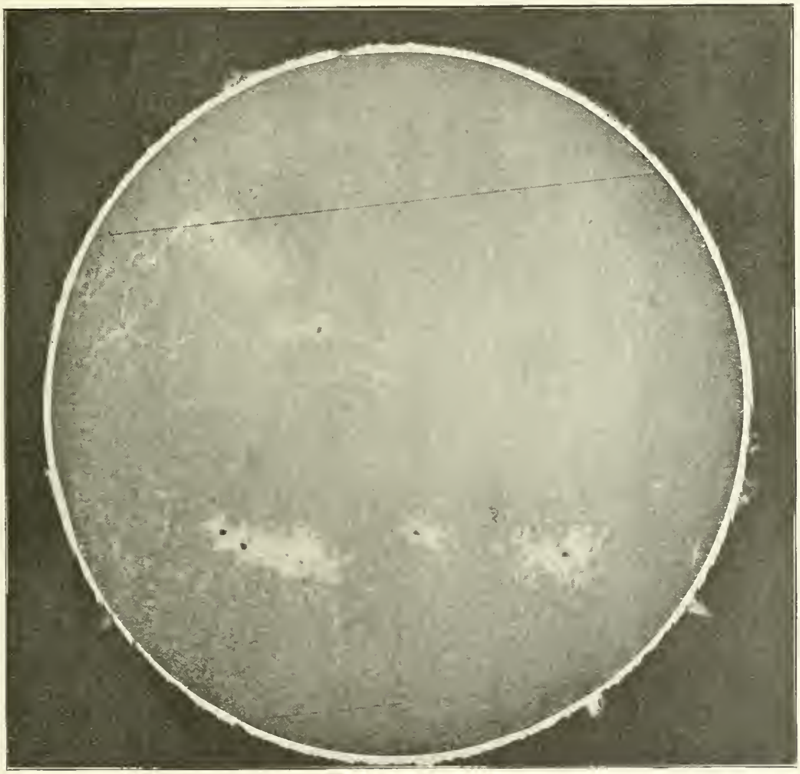

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PLATE III.—The Sun as Photographed in "K" Light on August 29, 1904.

Exposure for Limb 2 h. 49 m. to 3 h. 13 m. G.M.T. (interval 24 m.).

Exposure for Disc 3 h. 16 m. 5 s. to 3 h. 16 m. 30 s. G.M.T. (interval 25 s.).

The N-Rays of Blondlot

By J. J. Stewart, M.A., B.Sc. (*Principal of the Technical Institute, Newport*).

In the early summer of the year 1903 M. Blondlot, of Nancy, published in the *Comptes Rendus* of the French Academy of Sciences an account of some remarkable experiments he had carried out on certain rays which were emitted by a gas burner. He found that an ordinary Auer burner sent out rays resembling those of light and capable of penetrating metals, black paper, wood, cardboard, &c. The rays, after passing through these obstacles in their path, were able to produce effects in the region beyond. These effects manifested themselves especially by their behaviour towards a small electric spark which they caused to become noticeably brighter. A record of this action was obtained by M. Blondlot, who arranged a pair of sensitive photographic films so that one was acted upon by the ordinary electric spark from a small induction coil, the other by the spark from the same coil under similar conditions except that in the second case the spark was excited by the presence of the rays and had thus become brighter. The enhanced brilliance of the spark is indicated by the different effects on the sensitive film, and pictures of the two films, one exposed to the action of a succession of sparks under the influence of the rays from the Auer burner for 40 seconds, and the other with the rays from the Auer burner cut off by the interposition of moistened paper, are given in an early paper by M. Blondlot. The absorption of these new rays by water, especially water containing salt in solution, or by moist paper is one of their remarkable and unexplained characteristics.

The emission of these rays was noticed by M. Blondlot when using a Crookes tube for the production of Röntgen rays. He was led to suppose that they were to be very generally met with and were given out by various sources of light and heat, such as an Auer burner or a piece of heated metal. As these researches were carried out at the University of Nancy, where M. Blondlot is one of the professors, he gave to the radiations the name of N-rays from the first letter of the name of the town. Experiments on the behaviour of the N-rays seemed to indicate that they were capable of refraction and polarisation like the rays of ordinary light, and a beam of the rays appeared to be made up of different rays of very various refrangibility.

Another strange property of the new rays was that of increasing phosphorescence. Thus, if the N-rays concentrated by a quartz lens were caused to strike upon a screen of sulphide of calcium already phosphorescing, the phosphorescence was increased. This has been used as a means of detecting the presence of the rays, but the effect of heat on phosphorescence is very similar.

Further investigation of the N-rays seemed to indicate that they were given out by all bodies in a state of strain—by a bent piece of steel, a stretched or bent rod, or a file in which, during the process of manufacture, the material was subjected to stress resulting in a state of permanent strain. Extraordinary accounts were given of the emission of N-rays from pieces of metal, such as old weapons found in excavated cities or amongst the remains of buildings dating from Roman times in the south of France.

Bending or stretching wood or metal was found to cause the emission of N-rays, which generally manifested themselves by causing increased phosphorescence in sensitive substances. Sonorous vibrations were next observed as exciters of N-rays. M. Macé de Lepinay gave an account of experiments which showed increased luminescence of sulphide of calcium in the presence of sonorous bodies, such as cylinders of bronze when set in vibration. Even the alternate compressions and rarefactions of the air when transmitting the vibrations of sound seemed sufficient to originate N-rays and increase the brightness of a phosphorescing screen.

Further investigations by Blondlot led him to describe the dispersion of N-rays when refracted through prisms made of aluminium. As source of the N-rays in these experiments a Nernst lamp was used shut up in a cylinder of sheet iron in which a slit for the exit of the rays was arranged, which was closed by a sheet of aluminium permeable to the rays. The issuing N-rays were caused to pass through an opening in moistened cardboard (itself impermeable to them), and thus a beam of the rays was got, which was caused to pass through the aluminium prism and appeared to go out from it by another face, making an angle with the first, signs of dispersion by the prism being given in a way analogous to that of beams of light. The N-rays were drawn out into a spectrum—they appeared to be made up of various rays differing in wave-length. Measurements of the length of wave are given by M. Blondlot in his papers. He endeavoured to get a measurement of it by a sort of grating, and diffraction fringes were obtained. The phenomena of Newton's rings were also observed, and a whole series of phenomena resembling those obtained with waves of light.

Photography was employed to give a record of the changes of brightness produced by the N-rays, and the results got by Blondlot were confirmed by various observers in France. A remarkable thing about the repetition and confirmation of these experiments was that they occurred only in France. Observers in other countries endeavoured to repeat Blondlot's experiments, but with no satisfactory result.

A strange development of the work of research occurred when M. Blondlot published an account of a new sort of N-rays, which, while resembling those already described, had in many cases an inverse effect. They diminished instead of increasing the brilliance of a small electric spark when they fell upon it, and they caused a decrease in the phosphorescence of a sulphide of calcium screen. These rays it was proposed to call N'-Rays. Another property, both of these new rays and the N-rays themselves, was, that they become stored up in substances on which they strike. A brick exposed to the rays of the sun seems to absorb N-rays and give them out afterwards. A curious effect next noticed was that a screen feebly phosphorescing and exposed to the action of the N-rays, when viewed normally by a person straight in front of it, appeared more luminous than before, whilst it became less luminous if looked at very obliquely or almost tangentially.

Further researches were carried out on the transparency of different substances to the N-rays, and they were found to vary very much in this respect. Silver was found to be particularly transparent, and nickel and some other metals opaque to these rays.

The investigations were next taken up by various physiologists, especially M. Augustin Charpentier, of Nancy, who described how stretched muscle gave out N-rays. Phosphorescence was produced on a screen of barium platino-cyanide by means of a salt of radium, and it was found that on bringing up various portions of the human body to the screen the brilliancy of the phosphorescence was increased. Muscle and nerve

especially were observed to produce this effect, and muscle appeared to act more powerfully in proportion as it more strongly contracted. The effect was not due to heating of the screen, which would also tend to increase the phosphorescence, for means were taken to guard against this. M. Charpentier was led to the conclusion that the human body itself emitted N-rays. Further experiments seemed to show that from the frog and other animals N-rays were sent out. The portions of the body rich in nerves especially manifested this peculiar influence, and brightening of the phosphorescent screen was observed when such portions of a living organism were brought up to it. The compression of a nerve noticeably increased its power of vivifying the brightness of a glowing screen. Certain portions of the brain were especially active in giving out N-rays, and these portions could be localised on screens by the increased brightness which they produced. The behaviour of these radiations seemed to vary, and it was thought that the effects were due to rays which differed somewhat amongst themselves. The rays coming from nerve and brain were found to be stopped by a thin sheet of aluminium, while those proceeding from the heart, the diaphragm, and various muscles passed readily through aluminium and manifested their effects beyond the interruption.

Meanwhile M. Blondlot had been continuing his investigations, and various strange results were obtained. On examining still further the effect of compression he found that a large number of different substances acquired through pressure upon them the power of emitting the rays. Pieces of wood, glass, and caoutchouc behaved in this way. During compression they became sources of N-rays and increased the faint phosphorescence of a calcium sulphide screen. They also appeared to act directly on the retina (which is the result of the emission of N-rays), and caused the action of light upon it to be intensified. Thus, when the observer looked upon the face of a clock in a partly darkened room, which was so dimly lit that the clock-face was scarcely visible, and then bent a cane near his eyes, the compression of the cane had such an effect on his retina that the clock-face became clearly visible and the figures could be read.

Compressed glass had the same effect. These phenomena were not instantaneous; time was required for the effects to be observed. Bodies which were in a state of internal constraint were sources of N-rays. Tempered steel, hard-hammered brass, and crystalline sulphur were found to be permanent sources of these rays. A file or a tempered knife-blade acted like the compressed cane in brightening a clock-face in a dark room or in strengthening phosphorescence in a sheet of suitable material already excited. This emission of these mysterious rays apparently lasted for an indefinitely long time. A tempered knife-blade from an ancient Gallo-Roman tomb, as well as other similar ancient objects, behaved just as did a recently-made knife-blade. They emitted rays. The rays thus got in so remarkable a way were analogous to those of light. Spectra could be got, and the rays were capable of reflection, refraction, and polarisation, as are those of light. The energy thus appearing M. Blondlot considered was furnished by the potential energy which corresponds to the state of constraint of tempered steel.

[Our readers are doubtless aware that many experimenters have quite failed to obtain similar results.—Ed.]

Flint Implements Found by Accident.

By W. G. Clarke.

Many finds of Neolithic flint implements are in the nature of a surprise, as the following instances will suffice to prove. A Methwold farmer walking along the edge of one of his fields was attracted by a gleam of white at the foot of the hedgerow. Investigation disclosed a polished axe, curiously enough the only implement ever found on the farm. In this instance the finder knew what his discovery was, but a labourer at Flegg Burgh, Norfolk, was not so fortunate. He was ploughing and uncovered three axes lying side by side—two of polished white flint and one of chipped black flint. Thinking there was something uncanny about them, he kept the flints for a year to see if they would grow. As they did not, he made inquiries, and eventually found a purchaser. Numerous implements have been found projecting from earthen boundary banks. Such was the case with a fine axe firmly embedded in a roadside bank between Weeting and Brandon, and pulled out by a woodman struck by its unusual shape. Even more curious was an instance which occurred near Thetford. In the footpath leading to a gamekeeper's house there was a white stone, level with the surface and trodden upon by almost every passer-by. One severe winter it became loosened by frost, was kicked up by the gamekeeper stumbling against it, and found to be a white flint axe of the Cissbury type. As an example of a remarkable coincidence the following is noteworthy. Three men were walking over a heath in North-West Suffolk. They were not searching for flint implements, but the two outside men stooped down simultaneously and each picked up a perfect arrow-head. Even more strange is the history of the finding of the finest Neolithic axe yet recorded from East Suffolk. Between Carlton Colville and Kirkley, a railway line only used for goods traffic passes through a cutting. Abutting on this at one time was the playing field of a local school. One day as the boys were playing, a football was kicked into the cutting, and when the headmaster jumped over the fence after it he dislodged a big stone, which rolled down the slope. Its shape attracted attention, and he found that he had unwittingly unearthed a treasure. On one occasion the writer was searching the sides of a pit when suddenly a number of wasps came from a hole. Quickly stepping down the slope he disturbed a glistening piece of flint which proved to be a one-tanged lance-head of most beautiful workmanship. Many good implements have been found on stone-heaps. Some years ago Mr. E. T. Pengelly visited Norwich to give a lecture on Kent's Cavern. Prior to the meeting he had a short ramble, and from a stone-heap near Old Lakenham Church picked up a polished axe. Somewhat similar was the case of a labouring man at West Harling, who noticed a golden-coloured stone on a heap which had been collected from a field. He removed it, and it was seen to be a double-headed axe of yellow flint, magnificently chipped, and so thin as to be almost transparent; in fact, one of the best known English specimens. Numerous other examples could be given, but these are sufficient to prove that all Neolithic flint implements are not found as the result of systematic search, and that an element of chance enters into the discovery of some of the very best examples.

The "Tele-activity" of Chemical Reactions.

Many readers of "Knowledge" will, perhaps, be glad to hear of some research which offers an unlimited field for experiments, and which may also prove to be of some importance in several branches of manufacture.

Resonance in sound is familiar, both in practice and theory, to everyone; wireless telegraphy is an example of electrical resonance; in the former, the effects are produced by vibrations in the air; while, in the latter, the ether is the medium which transmits the disturbances. It does not require a very great effort of imagination to conceive that something similar may take place when waves in the ether are produced by means of a chemical reaction.

With the object of investigating this, several experiments have been proposed and carried out, but the results up to the present have not been very conclusive.

Two substances (mercury and iodine), which combine readily at ordinary temperatures to produce a compound easily recognised, were placed together in an open vessel. A vigorous chemical reaction (sulphuric acid on potassium chlorate and sugar) was allowed to take place very near it, and the mercury and iodine were afterwards compared with a similar mixture which had been prepared at the same time, and kept in another room. The amount of mercuric iodide produced in the protected vessel was much less than in that which had been exposed to the reaction. It was suggested that the heat produced by the reaction would account for the difference, and so the experiment was repeated with an asbestos mat placed over the vessel to shut off the heat, a thermometer being placed with the mercury. The temperature did not rise, but the effect was not as marked as before.

A photographic plate was then exposed to the same reaction (well protected, of course, from light rays), and when developed the image of lines on a piece of paper could be clearly seen. This, perhaps, may be explained in some other way.

It was then decided to determine whether one reaction would accelerate another. Two solutions were prepared containing the same quantities and proportions of sodium thiosulphate and hydrochloric acid. One was removed as before, while the other was exposed to the chlorate reaction. In every case it was observed that sulphur was deposited more quickly in the solution exposed to the reaction. These experiments were repeated, using blank cartridge to produce the disturbance, and very decided results were again obtained.

The strengths and proportions of the solutions were varied considerably:—

HCl	1 cc. (conc.) in 25 cc. water, to	
	1 cc. ,, in 50 cc. water.	
$Na_2S_2O_3$	1 gr in 125 cc water, to	
	1 gr in 75 cc. water.	

Proportions taken
5, 10, 15 HCl with 20, 25, 50 $Na_2S_2O_3$

Similar experiments were tried, using hydrogen peroxide and potassium iodide (with a little starch to show separation of iodine). The effect of the explosion was always to cause a sudden coloration of the solution, while an exactly similar solution prepared at the same time, but not exposed to the explosion, did not change colour until several minutes later.

About a week afterwards, these experiments were repeated; the results observed were similar to, but not as decisive as, those mentioned above.

The effect of the explosion of nitrogen iodide on a mixture of hydrochloric acid and sodium thiosulphate solutions, using same strengths as before in proportion of 10 to 50 cc., was a scarcely perceptible difference in the rates of deposition. When the proportions were altered to 13 to 50 cc., the difference was very decided.

The above results were thought to be due to the shaking produced by the explosion, but it was found that there was no difference in the rates of deposition of the sulphur, if one were shaken mechanically, and the other not.

Both chemical combination and decomposition have been employed to affect another reaction at a distance, but in all cases the results, when critically examined, were hardly decided enough to warrant the assertion that one chemical reaction can be influenced by another when there is no apparent communication between them. An accident, however, showed that this was at least possible. A large quantity of the chlorate and sugar mixture had been made up in proportion not noted. A little of this was placed in a basin, and while the rest of the mixture was held behind the operator, in a large mortar, strong sulphuric acid was added to the former, causing it to ignite in the usual way. Immediately afterwards, the rest of the mixture blazed up, although it was impossible that sulphuric acid could have got to it.

Similar mixtures in a great number of different proportions have been prepared and tried, but up to the present the exact proportions necessary for a repetition of the above phenomenon have not been ascertained.

It was thought that the desired result might, perhaps, be obtained if the two mixtures were connected in some way—by a wire or piece of glass tubing—but these methods have given no results. The experiments have been tried using similar and dissimilar substances:—Chlorate and sugar on a similar mixture; nitrogen iodide on nitrogen iodide; chlorate and sugar on a mixture of these substances, but in different proportions; chlorate and sugar with nitrogen iodide; also strong sulphuric acid and water, strong acids and solid caustic soda have been used as primary reactions, molecular proportions always being employed. When solid substances are used, the effects are not obtained, probably because the substances or proportions are not "in tune"; while when liquids are used a certain amount of action is observed, but the greatest possible effects are not produced.

One other experiment awaits a satisfactory explanation: Some nitrogen iodide had been prepared and kept for nearly a month suspended in a solution of ammonia. The day on which its services were required had been devoted to a large number of experiments with potassium chlorate and sugar. The ammoniacal nitrogen iodide solution was carried across the laboratory, with the object of being filtered and dried, and placed on the bench where the above experiments had just been carried out. It had only been there five seconds at the most, when it exploded with its customary violence.

Of course it may be only a coincidence—even then, the object of the investigation is to explain these "coincidences"—or it may be that a violent chemical reaction converts the space in its immediate vicinity into a medium that will accelerate or even induce chemical activity. This latter does not appear an impossible ex-

planation, and it should be thoroughly investigated before being rejected.

If it be true that one reaction does influence another, the importance of the investigation cannot be over-estimated. The preparations and violent reactions that go on from day to day in a laboratory may be altering (and those accustomed to manage a chemical laboratory know how certain substances do unaccountably alter) the molecular arrangement of the substances in the neighbourhood of the demonstation benches.

This, moreover, raises the question: "Does the weather influence the communication between one chemical reaction and another?" As has been stated above, it was observed that the results of the experiments varied (in degree) from day to day.

A thorough investigation of this subject may shed a new and more satisfactory light on the cause of intra-molecular action.

Among the few experiments described above, there may be some that will suggest others which will lead to more decided and consistent results, so that if it be possible to control chemical reactions at a distance, further research would show how it can be most efficiently demonstrated.

A. F. B.
B. I.

Practical Meteorology.

II.—Rainfall.

By William Marriott, F.R.Met.Soc.

In the present article it is proposed to deal only with the rain after it has reached the earth. In the term "rainfall" is included rain, snow, hail, dew, mist, &c. The rainfall is always expressed in inches, and is supposed to represent the height to which the rain would rise on the level ground if none of the water were permitted to run off or percolate through the soil, or to evaporate.

The instrument used for measuring the rainfall is called a rain gauge. This is best made of copper, and should have a circular funnel of five or eight inches diameter. It is very desirable that it should be of the Snowdon pattern, which has a deep rim to retain snow (Fig. 1). The gauge should be placed in an open and well-exposed situation free from trees, walls, and buildings; and should be firmly fixed so that it cannot be blown over. The top of the funnel should be one foot above the ground, and be quite level. The measurement of the rain is effected by pouring out the contents of the can or bottle into the glass measure and reading off the division to which the water rises. The gauge must be examined daily. When snow falls, that which is collected in the funnel is to be melted by adding a known quantity of warm water, and entering the difference as rain.

Rain gauges should not be placed on walls or roofs, as the buildings themselves offer obstructions to the wind which carries the rain drops over the funnel and so gauges mounted in such positions collect less rain than those placed on the ground. This was demonstrated as far back as 1766, for in that year Dr. W. Heberden, F.R.S., had three rain gauges at work at Westminster—one on the roof of the dwarf tower of the Abbey, one on the roof of a house close by, and another in the garden of the same house. The amounts of rain collected by these gauges were:—

Tower of Westminster Abbey ..	12·10 inches
Roof of house	18·14 ,,
Garden	22·61 ,,

These differences were due almost entirely to the action of the wind.

Through the influence of Mr. G. J. Symons it was agreed some years ago to adopt 9 a.m. as the hour at which the rainfall should be measured each day, and the amount entered to the *previous* day. There had been much diversity in this matter, observers measuring the rain at various hours, *e.g.*, 8 a.m., 9 a.m., 10 a.m., noon, 3 p.m., and even midnight. As there are now nearly 4,000 observers in the British Isles, 9 a.m. is evidently the most convenient hour to the vast majority, and its adoption has secured uniformity in the measurement of rainfall.

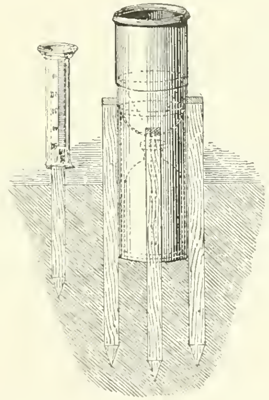


Fig. 1.—Snowdon Pattern Rain Gauge.

In hilly and mountainous districts, and in places where it is not possible to visit the rain gauge daily, the contents of the gauges should be measured monthly, the morning of the 1st of the following month being chosen for the purpose. These mountain gauges must be of sufficiently large capacity to contain the month's rainfall.

As everyone knows, the rainfall is very irregular, but, as a rule, there is most rain in the autumn and winter, and least in the spring. The following figures give the average monthly rainfall at the Royal Observatory, Greenwich, for the 89 years, 1815-1903:—

January ..	1·80 ins.	July ..	2·45 ins.
February ..	1·52 ,,	August ..	2·33 ,,
March ..	1·52 ,,	September	2·25 ,,
April ..	1·61 ,,	October ..	2·72 ,,
May ..	1·95 ,,	November..	2·29 ,,
June ..	1·97 ,,	December..	1·95 ,,
Total for the year ..		24·36 ins.	

It will thus be seen (Fig. 2) that October is the wettest month with 2.72 ins., and that February and March are the driest months with 1.52 ins. each. Although the above values represent the average rainfall, the individual monthly falls are often greatly different. For instance, with regard to the month of October, the fall in 1834 was only 0.47 in., whilst in 1880 the fall was as much as 7.65 ins. Again, with

regard to the month of February, in 1821 the fall was 0.04 in., whilst in 1866 the fall was 4.03 ins.

Owing to the great variability in the rainfall, it is very desirable that the averages should be based upon as long a period as possible; most of the recognised authorities on the subject assert that the period should not be less than 30 years.

Meteorologists in particular, and the people of the British Isles in general, owe a deep debt of gratitude to the late Mr. G. J. Symons, F.R.S., for having commenced the collection of rainfall statistics in 1860, and for publishing the results yearly in the volumes of *British Rainfall*. The number of stations at the time of his death, in 1900, was over 3,400. He not only collected these statistics, but he also secured uniformity in the measurement of the rainfall and in the exposure of the gauges, and he thoroughly checked the accuracy of the returns sent to him. It is satisfactory to know that the work is still being carried on under the able supervision of Dr. H. R. Mill.

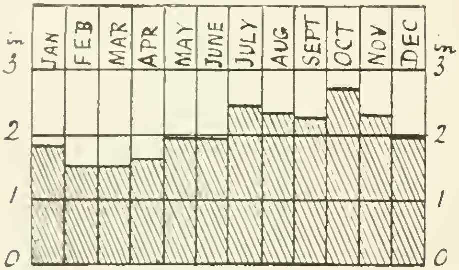


Fig. 2.—Average Monthly Rainfall at Greenwich.

From the rainfall maps of the British Isles compiled by Mr. Symons, Dr. Buchan, and Dr. Mill, it is seen that the average annual rainfall exceeds 40 inches along the western coasts, and that in several districts it exceeds 75 inches, chiefly the west Highlands of Scotland, the English Lake District, and the Snowdonian District of North Wales. Over the eastern part of Ireland and of Scotland, and the south of England, the rainfall is mostly between 30 and 40 inches, while over the eastern counties of England it is less than 25 inches.

The average annual rainfall of England is about 32 inches, of Wales 49 inches, of Scotland 47 inches, of Ireland 42 inches, and of the British Isles as a whole 39.5 inches.

At Seathwaite, in Borrowdale, Cumberland, the average annual rainfall reaches the large amount of 135.49 inches; while about a mile further away on the shoulder of the hill, near Stye Head, the average rainfall is 175 inches.

The average monthly rainfall at Seathwaite is as follows:—

January	..	15·51 ins.	July..	..	9·21 ins
February	..	12·03 ,,	August	..	11·52 ,,
March	..	10·35 ,,	September..		11·80 ,,
April	..	6·[illegible] ,,	October	..	14·06 ,,
May	..	6·[illegible] ,,	November..		13·82 ,,
June	..	7·49 ,,	December ..		15·87 ,,

The prevailing winds over the British Isles are mostly from the south-west. These come off the Atlantic warm and highly charged with moisture; and as they strike against the hills in the west, the moisture is condensed and falls as rain. Thus the heaviest rainfall occurs in the west, and the amount increases according to altitude.

A few years ago the author discussed the average rainfall for the 10 years 1881-1890, at 309 stations in England and Wales, grouping the stations according to altitude above sea-level. The results for each hundred feet were as follows:—

Altitude	100 ft.	..	Rainfall	27·69 ins.
,,	200 ,,	..	,,	30·50 ,,
,,	300 ,,	..	,,	31·49 ,,
,,	400 ,,	..	,,	32·49 ,,
,,	500 ,,	..	,,	40·64* ,,
,,	600 ,,	..	,,	37·38 ,,
,,	700 ,,	..	,,	39·01 ,,

These results show clearly an increase of rainfall with altitude.

Wishing to confirm the statement already made that the heaviest rainfall occurs on the west coast, &c., the author subdivided the above stations into western and eastern—considering those as "western" which drained towards the west, and those as "eastern" which drained towards the east. The following interesting results were obtained:—

				West	East.
Altitude	100 ft.	..	Rainfall	33·15 ins.	24·82 ins.
,,	200 ,,	..	,,	35·87 ..	25·94 ,,
,,	300 ,,	..	,,	35·72 ..	26.89 ,,
,,	400 ,,	...	,,	39·56 .	28·45 ,,
,,	500 ,,	..	,,	46·08* ..	29·87 ,,
,,	600 ,,	..	,,	38·08 ..	35·84 ,,
..	700 ,,	..	,,	41·25 ,,	35·27 ,,

These values show in a very striking manner that the rainfall is considerably greater in the west than in the east, the excess being nearly a quarter. If the stations had been more numerous, and if the observations had extended over a longer period, there is no doubt that the results would have been more uniform.

The place which has the heaviest known rainfall in the world is Cherrapunji, an Indian station situated in the south-west of Assam, on a small plateau forming the summit of one of the spurs of the Khasia hills. The hill on which Cherrapunji is situated rises precipitously about 4,000 feet from the lowlands of Cachar and Sylhet, which are barely 100 feet above sea-level. The south-west monsoon, advancing from the Bay of Bengal, sweeps over these low lands, and, meeting the hills, is suddenly deflected upward. Rapid condensation takes place and heavy rain falls. The average annual rainfall at Cherrapunji is about 500 inches, which fall mostly between April and September. In the month of August, 1841, the rainfall amounted to 264 inches. The heaviest rainfall in one day was 40.8 inches on June 14th, 1876.

The extremes in this country appear very insignificant compared with the amount just named, nevertheless they are often considerable. For instance, on August 6th, 1857, the observer at Scarborough measured $9\frac{1}{2}$ inches, but the rainfall actually exceeded that amount, as the gauge had overflowed. At Seathwaite 8.03 inches fell on November 12th, 1897. On July 14th, 1875, more than 5 inches fell over Monmouthshire. On June 23rd, 1878, Mr. Symons, at Camden Square, London, recorded a fall of $3\frac{3}{4}$ inches in an hour and a half.

It is these exceptionally heavy rainfalls which are so serious and which do such an amount of damage. It is, therefore, necessary for engineers and surveyors to know something of the rate at which rain may be

*These values are largely increased by the heavy rainfall at Seathwaite.

expected to fall, in order that they may be able to provide adequate means for the storm-water being carried away without causing floods. For this purpose self-recording rain gauges are of great value. These might with advantage be also used by other observers with whom "money is no object."

Fig. 3 is a copy of the trace by the self-recording rain gauge at the Fernley Observatory, Southport, which shows the heavy rainfall which occurred on September 10th, 1903, during the meeting of the British Association in that town.

Thunderstorm rains are often very heavy, but are mostly of a local character; they are also occasionally accompanied by hail. The hailstones usually take the form of little pellets or balls, and consist of compacted ice and snow. During the exceptionally violent thunderstorms which occurred at Harrogate and at Richmond, in Yorkshire, on July 8th, 1893, hailstones

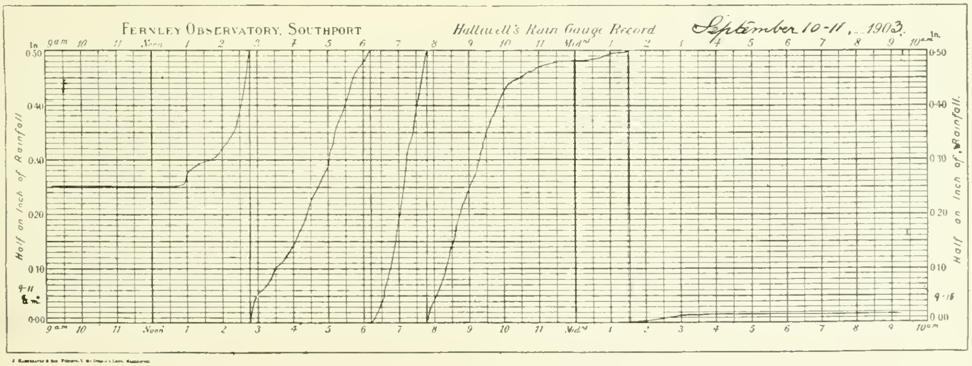


Fig. 3.—Record of Heavy Rainfall at Southport, September 10-11, 1903.

from 2 to 3 inches in diameter fell, and caused great destruction of property. These hailstones had several alternate coatings of opaque and clear ice. These coatings were no doubt due to the revolutions accomplished by the hailstones, which were probably several times drawn in towards the vortex of the storm.

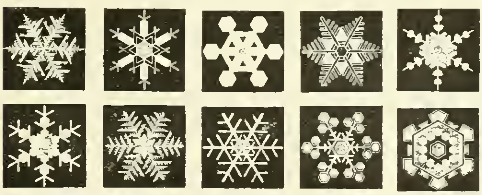


Fig. 4.—Snow Crystals, by Glaisher.

When the aqueous vapour in the air is condensed at a temperature below the freezing point it freezes and falls in the crystalline form of snow. Snow crystals are six-pointed stars, and are of great variety. The late Mr. J. Glaisher, F.R.S., observed nearly 200 different varieties of snow crystals between February 8th and March 10th, 1855, some of which are reproduced in Fig. 4.

Snow is much less dense than rain. A foot of snow is, *roughly*, equal to an inch of rain. Snow, however, varies greatly in density; with very dense snow, seven inches may equal one inch of rain, while with very light snow as much as sixteen inches may equal only one inch of rain.

A "rainy day" in this country is that on which a hundredth of an inch (.01 in.) of rain has been measured. The average number of rainy days in the year at the Royal Observatory, Greenwich, is 157; these are distributed over the months as follows:—

January ...	15	July	13
February ...	12	August ...	13
March	13	September ...	12
April	12	October ...	15
May	12	November ...	14
June	12	December ...	14

From a long continued series of rainfall records it is readily seen that there is a considerable variation in the annual amounts. The London records of rainfall show that from 1730 to 1750 there was a succession of dry years, and most of the readers of "Knowledge" will remember that there was also a succession of dry years (with three exceptions) from 1883 to 1902. The periods of successive wet years have been somewhat shorter than those of dry years.

With regard to the limits of fluctuation in the total rainfall, Mr. Symons arrived at the following conclusions:—1. The wettest year will have a rainfall nearly half as much again as the average. 2. The driest year will have one-third less than the average. 3. The driest two consecutive years will each have one-quarter less than the average. 4. The driest three consecutive years will each have one-fifth less than the average.

These conclusions are of the greatest importance to engineers when considering the question of water supply, for if provision is not made for "the driest three consecutive years," the result will most likely be a "water famine." There are many interesting subjects connected with rainfall, such as the influence of sunspots, periodicity, cycles of rainfall, &c., but these have not been discussed, as they are outside the scope of the present paper.

Star Map.—No. 4.

Perseus, Auriga, and Taurus.

The portion of the heavens here represented is one full of interest. In addition to the three well-known constellations named, we have the greater part of Orion, which forms one of the most conspicuous and easily recognised of all the constellations, as well as Gemini (the greater part of which has appeared in Map No. 6).

Orion is one of the useful star figures by which one's position is readily ascertained. The three stars forming the head are due north of the centre of the belt. The sword depending from the belt is an appropriate sign of the N. and S. line [1].

The Great Nebulæ of Orion, situated in the centre of the sword, is certainly one of the most remarkable objects in the heavens. This nebulæ, visible to the naked eye, and presenting a wonderful appearance on the photographic plate, seems to be but the centre of a huge spiral which extends faintly on all sides to the limits of the constellation.

There are a number of conspicuous stars in this part of the sky.

θ Persei (II. h. 37 m. + 48° 49′) is a triple star, of which two, A and B, are probably binaries, while C at a distance of 80″ does not share the same proper motion, and is, therefore, probably independent.

β Persei (*Algol*) (III. h. 2 m. + 40° 35′). This star has long been known as an extraordinary variable, hence called *El Goul*, "the demon." It has a regular period of variability. After being for 2 days 21 hours of 2·2 magnitude, it rapidly declines, until in just over four hours it is only 3·7 magnitude, after which it increases again in about the same time to its original magnitude. It is now practically certain that this change is caused by the interposition of a large dark body revolving around the brighter one, the orbit of which happens to be in a plane which passes through our earth. The two stars are probably very close together, and of much the same size. On September 3 it is at its minimum at 4 h. 42 m.a.m., from which time the other phases can be calculated.

The Pleiades (III. h. 41 m. + 23° 48′). This well-known cluster contains six stars visible to the naked eye. As most of them have a common proper motion, they doubtless form a system. A nebulosity surrounds all the principal stars. The length from Atlas to Celæno is 1° 6′. Those who have not considered the matter are often surprised to hear that this little group covers an apparent area much greater than that of the Full Moon (the mean diameter of which is 31′), and a representation to scale is therefore appended.

α Tauri (*Aldebaran*) (IV. h. 30 m. + 16° 19′). Magnitude, 1·1. Near this is the group known as the "Hyades."

On September 16 the Moon will pass across the region of the Hyades and Aldebaran. (Vide p. 236.)

α Aurigæ (*Capella*) (V. h. 9 m. + 45° 54′). Magnitude, 0·2.

β Orionis (*Rigel*) (V. h. 10 m. − 8° 19′). Magnitude, 0·3.

Nebula M. I. Tauri (V. h. 29 m. + 21° 57′). Known as the "Crab."

θ Orionis (V. h. 29 m. − 5° 25′). A multiple star situated in the Great Nebula of Orion. Four principal stars are of magnitudes 6, 7, 7½, and 8.

σ Orionis (V. h. 34 m. − 2° 39′). A multiple, composed of two sets of treble stars.

ζ Orionis (V. h. 36 m. − 2° 0′). A double star, magnitudes 2 and 6, with a faint companion 57″ distant of 10th magnitude.

α Orionis (*Betelguese*) (V. h. 50 m. + 7° 23′). A yellowish-red star, 1st magnitude. Variable to a slight extent.

β Aurigæ (*Menkalinan*) (V. h. 52 m. + 44° 56′). A spectroscopic binary, proving it to consist of two equally bright stars revolving in a period of 4 days.

The Great South Tropical Spot on Jupiter.

One of the most interesting and prominent features of Jupiter during the last four years has been a dark shading spreading more or less over the south tropical zone. It has been visible since the spring of 1901, and has maintained so striking an aspect, albeit a changeable one, that it promises to offer a parallel with the red spot and its surroundings as regards permanency.

Though situated in the south tropical zone of the planet its motion accords with that of the south temperate current which is about 9 h. 55 m. 19 s. from a mean of many spots seen at Bristol in recent years.

Between June 18th, 1901, and August 7th, 1905, the spot completed 3,655 rotations, with a mean period of 9 h. 55 m. 18.9 s., and it lost 16°.2 of longitude per month relatively to system II. (based on a rate of 9 h. 55 m. 40.63 s.) of Crommelin's ephemerides. The motion appears to have become gradually slower with the time, the rotation period having been about 9 h. 55 m. 18.5 s. in 1901, whereas it was about 9 h. 55 m. 19.5 s. in 1905.

In 1903 the average length of the spot was 48°, but when passing the red spot in July, 1902, it was about 87° long. I obtained an observation of the object on August 7th, 1905, as under:—

	H. M.	Longitude.
		°
P. end on C.M.	15 53	157·9
Middle ,, ...	16 28	179·1
F. end ,, ...	17 5	201·4

So the length on that occasion was 43·5. I used a 12½-in. Calver reflector, powers 300 and 440, but the latter was rather too high for the state of the air.

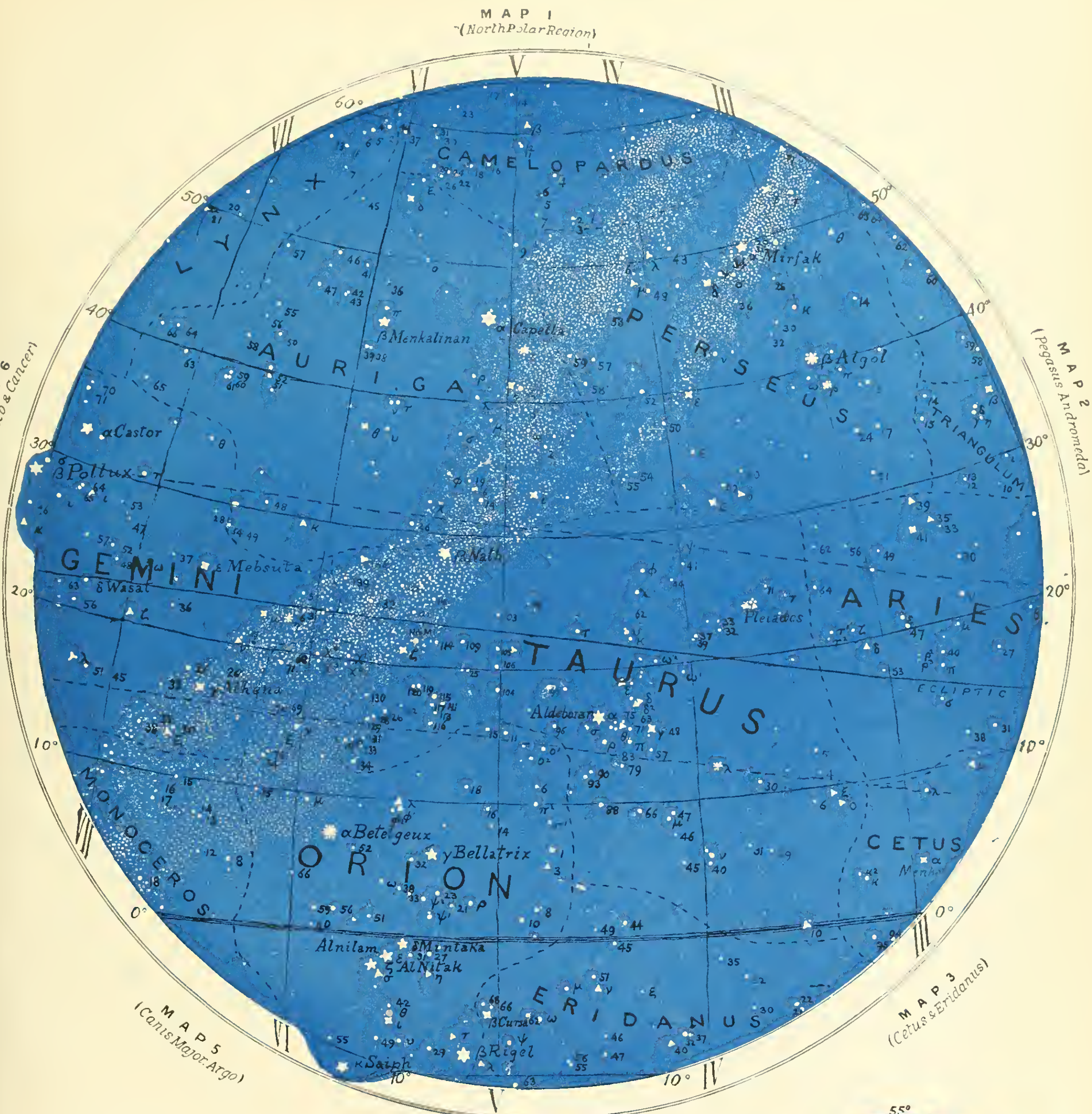
The durableness of this marking, its conspicuous appearance, and the fact that it has apparently influenced the very irregular motion of the red spot in and since 1901, render it a peculiarly important and attractive object for telescopic observers. It should be looked for in the following longitudes during the next two years:—

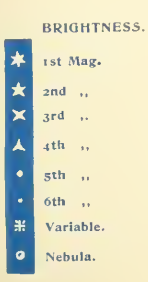
Date.			Longitude.
1905	September	15	158·8
,,	October	15	142·6
,,	November	15	126·4
,,	December	15	110·2
1906	January	15	94·0
,,	February	15	77·8
,,	April	15	45·4
,,	August	15	340·6
,,	October	15	308·2
,,	December	15	275·8
1907.	February	15	243·4
,,	April	15	211·0
,,	September	15	130·0

W. F. Denning.

Bristol, August 8, 1905.

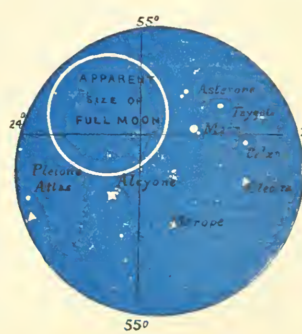
MAP No. 4.





MAP No. 4.

Perseus, Auriga, and Taurus.



The Pleiades.

Seaweeds:
A Holiday Paper for Field Botanists.

By David W. Bevan, Scarborough F.N. Society.

II.—The Red Seaweeds.

If the brown seaweeds are the giants of the shore, the red are the fairies. These little plants show an almost endless variety of form, but they are all really very much alike in build. Like all other lowly plants, the seaweeds are built up entirely of *cells*, and it is simply the grouping of these cells, and their way of dividing,

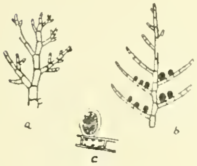


Fig. 1.

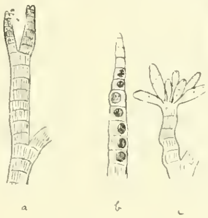


Fig. 2.

that determine the shape and appearance of the red seaweeds.

We have only time to glance at a few of those that are pretty sure to turn up. One of the loveliest little things for the microscope is *Callithamnion roseum* (Fig. 1—*a*). It is unfortunate that these little beauties have no "common" name. The botanical name means, in plain English, "The bonny bush of rosy hue." It is a simple row of oblong cells, with branches of the same pattern coming off right and left alternately, each cell of the branch again bearing a branch:—a bonny little plant, only about half an inch high, at most, growing often on the bare rock. Each cell contains a number of round, red bodies, corresponding to the chlorophyll

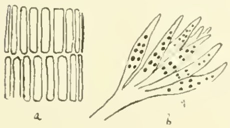


Fig. 3.

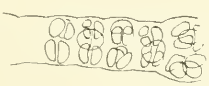


Fig. 4.

corpuscles of the land plants. Similarly, the brown seaweeds are brown because their colour-bodies are brown. But they all contain chlorophyll. Put bits of a red and a brown seaweed in alcohol for a few minutes; these colours are dissolved out, and the surprising fact appears that the brown seaweeds, and the red, are as green as grass.

Another *Callithamnion* (*floridulum*) entangles mud and sand in its branches, forming dense, dark red cushions up to two inches in thickness. As you wend your way over these cushions, you would scarcely suspect you were treading on a plant. On tearing the cushion open, we find the plant is dead below, but ever growing at the top—like the bog moss.

The most delicate seaweed known to the writer, and a pretty object for the microscope, is *Bangia*, a single, unbranched filament of extreme delicacy. It grows in the most reposed situations that are daily hammered by the waves. How it survives—and winter is its most flourishing time—is a mystery. Though it begins life as a single row of cells, a transverse section taken at maturity would pass through four cells, and these divide again to produce spores. Fig. 4 is a highly magnified view of a portion of a filament, the outlines only of the cells being shown.

The *Polysiphonias* (Fig. 2), with their long cells arranged like the staves of a barrel, and the *Ceramiums*, with their pretty forked and often curved tips, are very common; and they are all very beautiful under the microscope.

Fig. 5.

Fig. 6.

The commonest Polysiphonia, and one which is sure to be met with, grows in bushy tassels on the Knotted Wrack and it is as pretty as any of them. They all divide dichotomously, and can be recognised by the lens, as each "internode" of the filament has one large, central cell, and a number (varying in different species) of long, narrow red cells, arranged round it (see Fig.

Fig. 7.

Fig. 8.

3—*a*, which is a part of Fig. 2—*a*, more highly magnified). The Ceramiums are also dichotomous, and have, as a rule, curled tips. The naked eye shows they are made up of alternate light and dark coloured segments. While all are charming, words fail to describe the exquisite beauty of the Bristly Ceramium (C. ciliatum), when a small snipping is examined under either low or high power (Fig. 5—*a*). It grows at Scarborough on the front face of the limestone platform of the White Nab—a tiny plant only about one-third of an inch high—along with a little Polysiphonia with only four "staves" to its "barrel." This little Ceramium is easily known by its strongly-incurved tips, and by the colourless hairs growing on its frond. One's first impulse, on seeing this little beauty, is to call one's friends and neighbours together to share one's joy.

Fig. 5—*b* is a view of the very tip of a Ceramium frond, showing the regular method of cell division.

Other red seaweeds show their beauty without the aid of the microscope. Among them are the *Ptilota*, a splendid feathery plant, growing on stalks of the big Tangles, and the Mermaid's Comb (*Plocamium*), happiest below low-water mark, and easily recognised, because the frond bears branches on one side only, like the teeth of a comb, and these repeat the process. Fig. 11 shows a snipping of the frond enlarged. Others are *Chylocladia*, with sprays like branching rows of eggs, or beads, Corallines, with a white skeleton of carbonate of lime—formerly believed to be an animal allied to the corals—and the broad, leafy forms in great variety, from Porphyra, a flat sheet of cells, several inches across, lying flat and *black* on the rocks when the tide is out; Irish Moss (Chondrus), with a flat dichotomous frond, often rather curly; and a host of

Fig. 9.

others, till we reach the Rhodymenias, with frond of various patterns, and the Delesserias, with leaves exactly like those of land plants—midrib, veins, and all complete. Fig. 6 is part of a frond of *R. laciniata*, natural size; Fig. 7 is *R. palmata*, half size, and Fig. 8 is *D. sanguinea*, natural size.

The Irish Moss is one of the few seaweeds that are put to any use. It is still gathered, washed in fresh water, and dried, and in this state sold by the chemist for making jelly. The reader with a turn for experiment will be able to test its "virtues" for himself. We must not omit to mention, however, that the wracks are also useful to man. They are still largely

Fig. 10

Fig. 11.

used for making washing soda. The dried wrack is burnt, and the ash (known as "kelp") is thrown into water, when the soda dissolves, and can be easily crystallised out. (Another easy experiment for the enthusiast, best *not* performed in your seaside lodgings, as the special perfume produced in the burning does not commend itself to many.)

Burning reminds us of drying, and drying reminds us that the visitor to the seaside may wish to take dried specimens home. There are two difficulties to surmount in drying seaweed. The first is the salt in them, which is got rid of by a good soaking in *fresh* water. The second is the gelatinous nature of the frond of many of them, which causes them to stick to the drying paper. To prevent this, put between the seaweed and the paper a clean linen rag—old handkerchiefs are as good as anything else for the purpose. The stickiness of so many seaweeds can, however, be made use of, for if you take the paper on which you intend to finally mount the plant, and slip it into the bowl of water under the seaweed, you can then gently raise the paper with one hand, and with the other spread out the whole plant as it floats upon the paper. The most delicate plants can be easily mounted in this way. Now cover with rag and dry between drying papers. The plant will adhere firmly to its mount, while the linen prevents it adhering to the drying paper.

In searching for red seaweeds, it is well to look out for fruiting specimens. The process by which the egg cells are fertilised in the red seaweeds is very much more difficult to follow than in the brown seaweeds, but the result—the fruit—can, in many cases, be seen with the naked eye. It is sure to be found in summer on some of the Ceramiums (Fig. 5—*c*) and Polysiphonias, and when it is found on that fine plant *Ptilota* (a plant growing on the stalks of Tangles), it forms a very fine microscopic object. Fig. 2—*c* is a snipping of Polysiphonia with the male organs (antheridia).

The red seaweeds, however, have two strings to their bow. They produce not only fruit, by the union of male and female elements, but *spores*, without the need of such union. These always come in groups of four, and are hence called *tetraspores*. When these tiny spores are set free, they develop into new plants. Some plants have them outside, either sessile or growing on short stalks, while others have them inside, buried in the frond. They are easily seen with a lens, and better with the microscope. Callithamnion (the "bonny bush" mentioned above) is a beautiful object when it bears spores (Fig. 1—*b*, *c*). So is Nitophyllum, a pretty common plant with a broad flat frond. It shows on its surface distinct spots where the buried tetraspores occur. . . . (Fig. 9). A spore-bearing tuft of *Rhodomela*, about $\frac{1}{16}$ inch long, is shown enlarged in Fig. 3—*b*; and a small portion of it is again magnified in Fig. 10—*b*, where the dark spots are seen to be groups of spores, four in a group, but only three visible. These figures may be compared with those of *Polysiphonia* (Figs. 2—*b* and 10—*a*), in the last of which one of the barrel-shaped segments has burst and discharged the spores. Fig. 5—*d* is a bit of a *Ceramium* frond with tetraspores.

The red seaweeds appeal to the most cursory wanderer on the rocks, on account of their numerous and varied forms, and their obvious beauty. But the fortunate possessor of a microscope will soon find a wealth of hidden beauty in them which will much more than fulfil any expectations which this short article may have aroused.

It remains to say a few words about the Green Seaweeds, which have charms all their own, and these will form the subject of the third and last article.

The Word "Patent."

WITH reference to a letter appearing in our July number, "W." writes to ask if the word "Patent" is not merely a condensation of "Pattern entered." It is *not*, being derived from the Latin *pateo*, "to open," Letters patent being "open to the perusal of all." Pattern is derived from the French *patron*, an original model to be copied.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Star Streams.

THE *Times* correspondent with the British Association telegraphs from Cape Town on August 17th:—"In the mathematical section the most important contribution was made by Professor Kapteyn, Director of the Astronomical Laboratory of the University of Groningen, Holland, who read a paper entitled 'On Star Streaming.' Professor Kapteyn explained that he had been working for many years in making investigations into the structure of the stellar universe, and he had arrived at the remarkable conclusion that the proper motions of the stars are not distributed at random in space, but that a great part of the brighter stars belong to one or other of two great streams of stars moving in the plane of the Milky Way and meeting one another in space. This discovery opened up so many questions of the greatest interest that he had asked some of the most important observatories in the world to co-operate in several lines of research which must be carried through before the problem could be completely solved. Professor Kapteyn stated that he required in particular the determination by the spectroscope of the motion in line of sight of a great number of stars down to the eighth magnitude, and he hoped that the Royal Observatory would furnish him with much precious material of this kind."

Algol Variables.

On the 18th he reports: "In the Mathematical Section something of the nature of a sensation was created by a remarkable paper by Mr. Jeaus, of Trinity College, Cambridge, on the theory of argol (? Algol) variables, which excited the enthusiastic interest of Professor Darwin, Sir David Gill, and other astronomers.

Recent Observations of Jupiter's Sixth Satellite.

In a telegraphic despatch from the Lick Observatory it is stated that Professor Albrecht has observed the new sixth satellite of Jupiter with the Crossley reflector, the following being the determined positions:—

G.M.T.	Position Angle.	Distance.
1905.—July 25·95	55°·0	25''·1
,, 26·97	52°·7	24''·3
,, 27·93	50°·7	23''·6

The North Polar Cap of Mars.

From November, 1904, to May, 1905, Mr. Lampland was successful in obtaining a big series of determinations of the various features of the north polar cap of Mars. In a summary of the results tabulated, he gives the various aspects presented on various dates during the above period. On January 13, 1905, the cap was shrouded by an extensive veil of dull white; this was eventually pierced by the cap, showing as a brilliant spot about 4° in diameter, and then as a contoured patch some 9°·7 across. The veil was of the same nature as had been obscuring the cap since October 30, and appeared to consist of haze or cloud. From this time onwards many measures of the diameter of the polar cap are given.

On January 19, subsidiary snow patches began to appear from under the veil.

During April no signs of the surrounding white collar were visible, and from a close study of the epochs of its appearance and disappearance, it is thought that it may be something like a spring mist, surrounding the cap during the hotter months of its melting, and this view is supported by the feature of its indefinite boundary. The snow cap proper is girdled during its contraction by a blue belt, due undoubtedly to the material formed by its melting, which can be none other than water from among all the substances we know, whilst the collar lost itself unedged in the surrounding ochre, thus exhibiting the indefiniteness of cloud.

When the white collar disappeared, subsidiary outlying snow patches stood revealed, flanking the true cap about. Of these, the first to show was the great patch in longitude 206 . This was first seen by Schiaparelli in 1888; it was independently discovered at Flagstaff in 1901, and re-observed there in 1903 and 1905.

In 1905, the next most prominent subsidiary patch lay in longitude ±°10, just east of the Mare Acidalium, and a third set was found in about longitude 311°.

Proposed Magnetic Survey of the North Pacific Ocean.

The rapid development of commercial activity in the Pacific region during recent years has rendered necessary the institution of a definite scheme for determining more reliable values of the magnetic elements for those navigating these waters. Except for data from occasional special expeditions, and such as were acquired in wooden vessels many years ago, the present magnetic charts in use depend largely upon observations made on islands and along the coasts. It is evident, however, that such determinations are rarely representative of the true values on account of prevalent local disturbances.

The present plan is to be started under the patronage of the Carnegie Institution, from which an initial allotment of £5000 has been obtained to cover expenses during 1905. The scheme provides for the chartering of a wood-built, non-magnetic sailing vessel of about 600 tons, which, after starting from San Francisco, will pursue a clockwise spiral course, embracing the entire North Pacific Ocean. The total length of the proposed cruise is about 70,000 knots, and it is estimated that the work will occupy about three years.

It is fortunate that the region under consideration contains magnetic observatories in sufficient number and proper distribution for furnishing the necessary corrections to be applied to the observed magnetic elements in order to reduce them to a common epoch. For this purpose, continuous records of the magnetic variations will be available from Sitka (Alaska), Mexico, Honolulu (Hawaiian Islands), Manila (Philippines), Shanghai (China), Tokio (Japan). In addition, it is hoped that a station will soon be started in California, and that the German Government will continue its magnetic observatory at Apia throughout the period of the survey.

Monochromatic Photographs of the Orion Nebula.

Professor J. Hartmann, in the course of a series of experimental trials of a small quartz spectrograph, has recently obtained photographs of the Orion nebula, which show important differences in the composition of its several parts, indicating that different parts of the nebula emit light of different composition, and that extensive areas of characteristic form shine almost solely with ultra violet light of wave-lengths 3727.

With this small camera the images are, of course, small; 1 mm. on the plate corresponds to an angle of about 10 , but this was found quite sufficient to permit the recognition of the various parts of the nebulous areas. It was found advisable, however, to be able to utilise apparatus of higher power, and this was done by the use of suitably stained colour screens. The most useful of these are: (1) *Picric acid*, which transmits the longer wave-length, especially the nebular lines N_1, N_2, and $H\beta$, and absorbs all wave-lengths shorter than 4800; (2) *Quinine cobalt*, which transmits only the rays between 3880 and 3740; (3) *Nitroso filter*, the absorption of which begins at 5050, but dies off again near 4000, and 3727 is easily transmitted. By suitable combinations of these, photographs have been obtained with a Steinheil mirror of 24 cm. aperture and 90 cm. focus.

The chief result is the remarkable intensity of the 3727 radiation in *all* parts of the nebula.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

On Antimony in Rubber Rings.

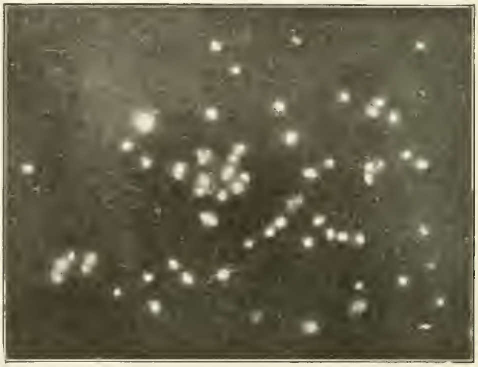
A paragraph with the sensational heading "Poison in Stoppers" appeared recently in one of the daily papers, and purported to be an interview with a Liverpool doctor. This gentleman was reported to have examined the red rubber rings so largely used for the stoppers of mineral water bottles, and to have asserted that a poisonous dose of antimony could be removed from them by a simple washing with cold water. In fact he is stated to have attributed many deaths within his own experience to this cause. As such stoppers have been in use for over 30 years, and are now almost universally employed, the question is one of the greatest importance, and the present writer has therefore made experiments to determine the degree of truth in the charges here brought against them. These red rings certainly contain a large proportion of antimony in the form of the pentasulphide, and it is to this that they owe their colour. Quantitative determinations showed that the proportion of this pigment in the rubber amounted to 15 per cent. or more. Experiments were next made to discover to what extent this antimony was soluble. The rings were boiled for over an hour with water, but absolutely no trace of antimony could be detected in the liquid. As it seemed possible that in practice the rubber of the rings might become worn and fragments fall into the bottle and so be inadvertently swallowed, parallel experiments were made with hydrochloric acid of 10 per cent. strength. *i.e.*, much stronger than the acidity of the gastric juice; but in this case, too, the liquid was quite free from antimony. This is not surprising, since it is well known that antimony pentasulphide is only soluble in alkalies and concentrated acids; and hence it would seem that there must be some error in the report about the stoppers examined in Liverpool. At the same time it would be advisable for the manufacturers of the rings to replace antimony sulphide by some pigment above suspicion. For although as at present employed the rubber-ringed stoppers may be regarded as quite safe, there are conceivable cases in which the antimony might be brought in solution—*e.g.*, by contact with strong potash. The effects of antimony upon the system are very similar to those of arsenic. Both are irritant poisons, and both are cumulative in their action. It is well known that the dead bodies of the Styrian arsenic eaters remain undecomposed for years, and this preservative effect is also a characteristic of antimony.

The Formation of Radium from Uranium.

A very interesting discovery made by Mr. F. Soddy furnishes new evidence in support of the now generally accepted view that one element can, under certain conditions, be transformed into another. A solution containing over 2 lbs. of uranium nitrate was freed from all radium that it contained by repeated precipitation, and was then kept for 18 months in a closed bottle. It was examined from time to time, and it was found that it gradually acquired the power of emitting an emanation absolutely identical in characteristics with that given off by radium. Hence the conclusion was arrived at that the uranium was very gradually transformed into radium, though only traces of the latter substance were present in the solution at the end of the period of observation.

Thorianite: A New Mineral from Ceylon.

One of the most valuable minerals known has recently been examined by Professor Dunstan and Mr. Blake at the Imperial Institute. It is found in the form of small dark cubical crystals in gem-bearing deposits in rivers in Ceylon, the principal source being the bed of the small stream, Kuda Pandioya, but it is not known from what kind of rock the deposit is derived. The mineral varies in colour from dull grey to dark brownish-black, and many of the crystals have a polished appearance from having been worn in the bed of the river. It is nearly opaque, except in very thin layers, is very infusible, and becomes strongly incandescent when heated to a high temperature. Its density is about 9·7. It can be readily powdered, and dissolves easily in dilute sulphuric acid, yielding a gas which consists mainly of helium. It is composed principally of thoria (thorium dioxide), the amount of which ranges from about 70 to 80 per cent. It also contains from 10 to 12 per cent. of uranium oxide and rare earths, and smaller amounts of oxides of lead and iron. One specimen was found to contain 0·39 per cent. of helium. The commercial value of thorianite is due to the free thoria, which is



Action of Thorianite on a Photographic Plate in the Dark.

used in the manufacture of mantles for incandescent gas burners. Hitherto the chief source of this oxide has been monazite sand, which contains only a small percentage of thoria. Consignments of the new mineral from Ceylon have been sold in this country for as much as £1500 per ton. Radium has been identified in thorianite, which is one of the most radio-active substances known, though it is not quite so active as some of the pitchblendes examined by Madame

Radiograph of a Shilling taken through Paper by means of Thorianite.

Curie. The present writer has had the opportunity of examining a number of specimens of thorianite and testing their radio-activity, and some of the results are shown in the accompanying figures. In the first case the thorianite was sprinkled over the photographic plate and left for 12 hours in the dark, and in the second experiment a shilling was placed on the plate and covered with paper, on which the mineral was scattered. It is interesting to note that the radiations must have been reflected beneath the coin in such a way as to obtain an image of the device.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

The Slaughter of Ravens and Peregrines.

The *Field* (July 29) contains a short account of the ruthless persecution meted out to Ravens and Peregrines in Argyleshire, which is anything but pleasant reading. Though we fully realise that these birds, if too numerous, are a menace to farmers and game preservers, there can be no doubt but that anything like a war of extermination is not only unjustifiable, but foolish. The determination and ruthlessness shown by the stalker on the occasion described by the writer are worthy of a better cause; and we are glad to note that he, too, considers the incident regrettable. "Surely," he remarks, "such persecution as that of the raven and falcons might well be stopped, at all events, in the breeding season. The sight of a falcon on the wing is to many sportsmen a real pleasure, and, in my opinion, a few grouse might well be spared to them."

Nesting of the Egyptian Plover.

The remarkable nesting habits of the Egyptian Plover, *Pluviums ægyptius*, have given rise to considerable discussion during the last twenty years or so. The *Field* (August 5) contains an interesting note on this subject, which may be regarded as finally clearing up the matter. Brehm, it may be remembered, stated that this bird buried its eggs in the sand, where they were hatched, while Dr. Von Heuglin, on the other hand, said that he had always found them uncovered. From careful observations of Mr. A. L. Butler, it would seem that Brehm was right. His attention was drawn to the subject by the apparently aimless wanderings of a pair of these birds on a sand-bank on the Rahad River. At last one sat down, and remained seated for nearly an hour. Flushing the bird he endeavoured unsuccessfully to find the eggs. The next day the bird came and sat on the same spot, and a second search revealed two eggs about an inch under the sand. This was at noon, and the sand was burning hot, hence he concluded that the bird visited the eggs at about this time to shield them from this excess of heat, the incubation being performed by the heat of the ground.

Hemipodes Breeding in Confinement.

The value of the work done by the "aviculturist," is slowly beginning to obtain recognition, and no one has done more to bring about this change of opinion than Mr. D. Seth-Smith, who has attained a series of quite remarkable successes in inducing rare types to breed in captivity. After much care and trouble his endeavours to breed the variegated bustard quail (*Turnix varia*) have been rewarded, and he is to be congratulated, for many new facts concerning the habits of these birds at this time have come to light. In the August number of the *Avicultural Magazine* he gives a long and extremely interesting account of his observations. It has long been known that among Turnices the females are the more brilliantly coloured, and that as is the rule in such cases the male undertakes the work of incubation, while the female does the courting. How this is performed is particularly well told by Mr. Seth-Smith in the article referred to. "The male," he writes, "squats among the grass, and the female runs round him. . . . with tail more or less erect, and crop extended and carried close to the ground. Having run round him once or twice she stands facing him at a distance of about a foot. . . . and commences 'booming' or 'cooing' to him like a cock pigeon, at the same time stamping and scratching with her feet, while the male responds with a faint clucking noise." Like the Tinamous, Mr. Seth-Smith believes these birds are polyandrous.

A White Swallow.

Mr. Henry Taylor records in the *Field* (August 12) the fact that a white swallow is daily to be seen at his house at Dyson's Wood, near Caversham. When it first appeared it would seem that the swallows of the neighbourhood endeavoured to drive it away, but they have now apparently grown used to its presence, and in no way molest it.

Dartford Warbler Breeding in Sussex.

The *Zoologist* for August records the breeding of the Dartford warbler at Maresfield, in Sussex, in May last, and the birds appear to have been successful in rearing their young.

Albino Starling.

The Rev. Julian Tuck records the fact than an albino starling was shot at Beyton, in Suffolk, in June last. It had apparently only recently left the nest.

Dotterel in Rutland.

The *Field* (June 3) records the occurrence, at Ridlington, of seven Dotterel, *Eudronias nurinellus*, which were kept under observation in a field for half-an-hour. "Mr. Horn," says the writer, "previously saw the same number at Moscott on May 21.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Professor Rutherford has been making further determinations in connection with the particles emitted by radium. Some of his results may be chronicled here. He finds that the total number of Alpha particles expelled per second from one gramme of radium bromide at its minimum activity is $3{\cdot}6 \times 10^{10}$; and assuming that the composition of the compound employed is Ra Br_2, it follows that the total number of Alpha particles expelled per second from one gramme of *radium* at its minimum activity is $6{\cdot}2 \times 10^{10}$. Now the Alpha ray activity of radium in radioactive equilibrium is four times this minimum value, and includes three products—viz., the emanation, radium A and radium C—which emit Alpha rays. Hence he concludes that the total number of Alpha particles expelled per second from one gramme of radium in radioactive equilibrium is about $2{\cdot}5 \times 10^{11}$. This result is deduced from the current produced in a nearly perfect vacuum when all electrons (which carry a negative charge) were bent aside by a magnetic field. The close agreement between this value and the value previously obtained from direct data based on the heating effect of radium, and the observed volume of the emanation, leaves now no room for doubt that the Alpha particles carry a positive charge at the moment of their expulsion from the film of radium salt, though at one time he was inclined to doubt that they do. Accepting this conclusion, there is no obvious reason for supposing that they are not charged at the moment of their expulsion from the radium atoms themselves; for it should be noted that the film of radium bromide employed was very thin.

He has also determined that the number of Beta particles expelled from one gramme of radium per second is about $7{\cdot}3 \times 10^{10}$ which is only a little in excess of the number previously obtained for radium at its minimum activity. The results indicate that four Alpha particles are expelled from radium in radioactive equilibrium for each Beta particle, and thus confirm the theory of successive changes which Rutherford has done so much to develop.

If it be assumed that only one Alpha particle is expelled during the disintegration of the radium atom then it follows that the number of atoms which break up per gramme per year is $1{\cdot}95 \times 10^{16}$. Taking the atomic weight of radium as 225, it follows that about half a milligramme per gramme disintegrates per year. It therefore takes about 1280 years for half the radium present to be transformed.

The Pendulum Accelerometer.

Mr. F. W. Lanchester has devised an interesting apparatus for measuring accelerations directly. It is clear that this might be done by mounting on the moving object (*e.g.*, train or motor-car) a spring balance, the mass being mounted so as to permit of its horizontal motion only. The acceleration of the mass (and therefore of the train) would be directly

proportional to the extension of the spring. Mr. Lanchester prefers the easier method of arranging the mass as the bob of a pendulum. This pendulum becomes deflected whenever the point of support receives an acceleration, and from the angle of deflection the acceleration is determined; in fact, the horizontal acceleration bears to that of gravity a ratio equal to the tangent of the deflection. The first instrument of this kind was made by him in 1889. In the 1904 model an improvement has been effected in the mode of automatically recording the acceleration. Since this quantity is proportional to the tangent of the deflection, the recording pencil must be so arranged as to move equal distances for equal increments of deflection. This result is attained by pivotting the pencil arm to the pendulum continuation in such a manner that the point of the pencil lies always in the plane of the pendulum axis. It is assumed in the theory of the instrument that the motion of the pendulum bob is substantially that of the rest of the vehicle, and consequently its motion of swing should be negligible in comparison with the motion of the vehicle. Its time of swing must also be kept small compared with the time of change of acceleration which it is required to record. This necessitates the use of a very short pendulum, which in the later model is reduced to 1¼ inches. An oil dash pot is employed to make the movements deadbeat. A characteristic feature of diagrams taken by means of this instrument is the suddenness of the drop at the instant of stopping. This represents the jerk nearly always experienced just as a train comes to rest. A jerk consists in fact of a very sudden change in acceleration, and not of a large acceleration. Mr. Lanchester suggests that the term "jerk" might be given a scientific meaning by defining it as the rate of change of acceleration. To prevent this jerk the brake of a vehicle should be taken nearly off before completely stopping. For further information the reader is referred to the *Philosophical Magazine* for August.

The Methods of Physics.

In mathematical physics we employ two kinds of theories, which may both lead to an understanding to a certain extent of what goes on in the material world, and which are nevertheless very different in their nature and in the aims which they declare. In the theories of the first kind, it is sought to penetrate the intimate mechanism of phenomena; we endeavour to represent the motion of molecules and atoms, and, as one must now add, also of ions and electrons; we determine their velocities and dimensions, the masses and electric charges of these extremely small particles. All this is foreign to theories of the second kind. Physicists who prefer these concern themselves only with magnitudes which are accessible directly to our observations, such as temperatures, quantities of heat, electric currents, &c. After having measured these magnitudes they establish their mutual relations, and show that these relations are in accordance with certain general principles, amongst which the law of the conservation of energy and the second law of thermodynamics are the most important. H. A. Lorentz, La Thermodynamique et les théories cinétiques (*Journal de Physique*, August, 1905).

ZOOLOGICAL.

By R. Lydekker.

The Lower Jaw of Mammals.

Hitherto it has been generally supposed that the lower jaw of mammals differs fundamentally from that of birds and reptiles in that each lateral half is formed of a single piece, instead of comprising a number of distinct elements. According, however, to recent investigations on the jaws of embryos undertaken by Professor Carl von Bardeleben, this is a mistaken idea, and in the young condition the mammalian jaw shows the same compound structure as that of a bird or a reptile. The mammalian jaw is indeed now stated to be strictly comparable in every detail with that of a reptile.

Mammal or Reptile?

A fossil skull from the Karoo system of South Africa described in 1884 by Sir R. Owen as that of a mammal, under the name of *Tritylodon longævus*, was subsequently assigned by Professor H. G. Seeley to the reptilian class. Recently Dr. R. Broom, in the Transactions of the South African Philosophical Society, has again pronounced in favour of the mammalian nature of the fossil. Taking all points into consideration, the author believes *Tritylodon* to be a mammal, whose nearest affinities are with the egg-laying duckbill and spiny anteaters of Australasia, which are evidently specialised survivors of a once abundant primitive group. Perhaps the real truth is that the South African fossil presents so many resemblances to mammals on the one hand and to reptiles on the other, that it can scarcely be assigned to either group, but rather forms a connecting link between the two.

A British Armoured Dinosaur.

Not long ago reference was made to recent investigations into the structure of the small dinosaur from the Wealden of the Isle of Wight, known as *Hypsilophodon foxi*. The same energetic investigator, Baron Francis Nopcsa, has published in the June number of the *Geological Magazine* an account of another dinosaurian reptile, *Polacanthus foxi*, from the same locality and formation. The restoration shows a long-bodied reptile of about three feet in height at the shoulder, with the hind-quarters invested in a solid bony shield, and the upper surface of the rest of the body, the neck, and the tail protected by a double row of large bony plates standing vertically. The creature may in fact be regarded as a kind of reptilian armadillo. It may be mentioned that the author takes no notice of the fact that the name *Polacanthus* is preoccupied by the designation applied to the paradise-fish (*Polyacanthus*).

Reptiles from North Greenland.

As affording additional confirmation to the idea that the Arctic regions once enjoyed a genial climate, considerable interest attaches to the description by Dr. E. Fraas, in *Meddelelser om Grønlands*, of reptilian remains from the Jurassic strata of Northern Greenland. The first of these is the footprint of a land dinosaur, while the second is a vertebra of one of the ichthyosaurs, or fish-lizards. It seems, therefore, that in Jurassic times the polar ocean was entirely free from ice.

An Extinct Sea-Lion.

Very little is known as to the past history of the sea-lions and sea-bears (fur-seals), and it is, therefore, a matter for congratulation that a fine skull has been obtained recently from the Miocene strata of Oregon. Mr. F. W. True, who has described the specimen, states that it is considerably larger than any existing sea-lion skull that has come under his notice, its basal length when entire being probably about twenty inches. The new name, *Pontoleon magnus*, is proposed for the fossil sea-lion, as the characters of the skull and teeth do not agree precisely with those of any living member of the group. It should be mentioned, however, that if all the modern eared seals are included in the single genus *Otaria*, as is still the practice with some zoologists, there would apparently be no reason to exclude the fossil species.

The Black Sea Porpoise.

According to the well-known student of the Cetacea, Dr. O. Abel, the porpoise of the Black Sea is quite distinct from the common porpoise of the Atlantic (*Phocæna communis*), the chief difference being apparently the form of the head. For this species the name *Phocæna relicta* is proposed. Seeing that the common porpoise does not enter the Mediterranean, it is only natural to expect that its Euxine representative should be distinct. Dr. Abel considers that the reason why porpoises do not enter the Mediterranean is because the water is too salt for them. In the same communication he describes a fossil porpoise-skull from the Miocene strata of the Taman Peninsula as *Palæophocæna*, regarding it as representing an ancestral member of the group.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The Developable Image.—Professor J. Joly, in his presidential address to the Photographic Convention, deals with the nature of the developable image. He considers the change to be of a physical nature, and with due reserve suggests photo-ionisation as the cause, admitting, at the same time, that he has not as yet been able to detect any electronic discharge from the film under light stimulus. I should like to ask whether the wonderful persistence of the developable condition is not a considerable difficulty in the way of accepting such a theory. Whether or not it is supposed that the almost inconceivably minute stimulus that we know to be sufficient to produce the developable condition does so by effecting a change in the electrical condition of the salt, it must be remembered that the changed state of the salt is able to persist for years in an aqueous and salt-containing medium, that is, without insulation, and in the case of the Daguerreotype on the surface of the best known conductor. As Professor Joly says, "our knowledge of the electron as an entity taking part in many physical and chemical effects, should be kept in sight in seeking an explanation of the mode of origin of the latest image," and it is, I submit, of even greater importance to be guided by known facts and experimental data, and to go forward in our conceptions only as these justify our progress. Ionisation may serve well as a working hypothesis, whether or not the future will prove, but I think it should not be accepted even as a possible theory of the nature of the developable image until some definite experimental support can be shown in favour of it.

Measuring Vessels.—I suppose that it is correct to regard weights and measures simply as conveniences, and to value all arguments put forward in favour of this or that system by comparing them from the same point of view. The superior convenience of one system over another may be the merchant's, or it may be his customer's, and then the man of business has to endeavour to find the value of the respective conveniences that he may follow the more profitable course. The practical photographer is not concerned with profits in this matter, but only with minimising his own trouble. Unless one is already more accustomed to the metric system, there can be no doubt that, at present, the ordinary English weights and measures are more convenient for English people, for all English formulæ are so expressed. But among all the arguments set forth in favour of either our present methods or the annihilation of them in favour of the metric system, there is one very practical matter that I do not remember having seen emphasized as it deserves to be, namely, the shapes of the measures in common use. Whether one purchases a two-dram, two-ounce, four-ounce, pint, or quart measure, it is almost always of a convenient shape, but measures on the metric system are tubular. Of course, a narrow tube is better adapted for exact subdivision, but exactness is not the primary desideratum of the practical photographer—an error of a few per cents. on either side of the true capacity is negligible because the effect of the difference is rarely recognisable. The photographer wants convenient vessels for pouring from and into, when a flat dish is the other receptical. I think this simple but very practical matter well worth the serious attention of those reformers who are seeking to get the metric system universally adopted.

Fine Grained Images.—Messrs. Lumière and Seyewetz find that a finer deposit than otherwise is obtained by developing slowly (by adding either water or a restrainer) in the presence of a solvent of silver bromide. For this latter they use from 15 to 20 grams of ammonium bromide to each 100 cc. of developer. Paraphenylene-diamine and orthoamidophenol need no such addition, as developing solutions prepared with them have the necessary solvent power. Working on such lines will probably be found to incur risks not usually met with. Silver in solution is liable to give stains, as with ammonia developers that were generally used before soda developers became so common. I think that the almost universal use of sodium carbonate instead of ammonia is a case of the survival of the fittest, and that it would not be well to go back to ammonia with all its uncertainties. A fine grained image is not everything, and the old wet collodion plate, which is often taken as the standard, if developed with ferrous sulphate, gave a coarse grain, though the particles were more uniform in size than is generally the case in gelatine plates. It is not so much the coarseness of grain in gelatine plates that causes trouble, as the presence of a comparatively small proportion of large grains, some of which appear to be often due to imperfect filtration of the emulsion, for they settle down to the lower side of the film. But granting that the proposed methods are not the best for general adoption, cases may arise where they will be serviceable, and it is very desirable to know the characteristic effect of any possible procedure. In the presence of the solvent of the silver salt, it is supposed (and doubtless it is a fact) that some of the silver that forms the image is deposited from solution, a kind of intensification effect, the other part being reduced, as usual, from the solid particles of salt as contained in the emulsion. It would be interesting to know what effect, if any, the double origin of the developed image has on the gradation.

Received.—J. H. Dallmeyer, Ltd., send a catalogue of their well-known lenses and other specialities. The frontispiece shows the usefulness of the "Adon," which, although a small lens intended for attachment to hand cameras, has here, used alone, given an excellent 12 by 10 photograph with a camera extension of 38 inches.

REVIEWS OF BOOKS.

The Preparation and Mounting of Microscopic Objects, by T. Davies (C. Arthur Pearson; fcap. 8vo, pp. 118; 2s.).—This is a reprint of a book which has had a large sale in past days; and, in spite of certain faults of arrangement, not only was well worth reprinting, but deserved to be reprinted in better style than the "edition" now before us. The book is manifestly merely a new impression from the old stereotype plates of 1873, though this is not mentioned; the binding and the paper have alone been altered—the latter very much for the worse. In fact, the paper is both thick and coarse, and quite unsuitable for the purpose, though the price at which the book is published would surely have justified more satisfactory treatment in this respect. The book itself is too well known to need criticism. It was, of course, written entirely for the amateur; and, though somewhat out of date now, contains much information on preparing and mounting objects for the microscope which is of real service.—F.S.S.

Half-Hours with the Microscope, by Edwin Lankester, M.D. (C. Arthur Pearson; fcap. 8vo, pp. 118; 1s.).—This is another reprint of a book which has been very popular in its day, but the same criticisms as to paper and printing apply also to this volume. Moreover, the book, dealing as it does in part with the microscope itself, shows its antiquity very markedly, though the publishers refrain from giving any direct information on the matter. For instance, on page 5 a microscope is illustrated which contains almost every feature that the amateur would be warned against now, and on pages 26 and 27 are two "illustrations" which are so worn as to be little better than shapeless smudges. The eight original plates of various objects are in much better condition, and the accompanying letterpress will still interest anyone who has just become possessed of a microscope and is eager to use it. —F.S.S.

Microscopes and Accessories: How to Make and Use Them. Edited by Paul N. Hasluck (Cassell and Co., Limited; pp. 160; 1s. net.).—It is difficult to know what to say of a book of this sort. It is one of a series of "Work" Handbooks dealing with such multifarious matters as beehives, boot-making, bamboo-work, &c. It professes to be a "comprehensive digest of the knowledge of microscopes and accessories, scattered over twenty thousand columns of 'Work,' a journal edited by the editor of this book. We have a great sympathy with amateur hobbies, and for all attempts to make things instead of buying them; but we do not think the microscope is a suitable instrument for home manufacture, and this little book, however praiseworthy in intention, confirms us in this. It would be easy to criticise the design and details of the suggested microscope, but we feel that any amateur who is capable of making even such a microscope as is described here, and of fitting it, moreover, with an elaborate iris diaphragm also of his own manufacture, is himself to be humbly admired rather than criticised. Instructions are also given on how to make "an improved mount for a cheap microscope," the result being such as may one day grace the collection of the Royal Microscopical Society as a curiosity, and give rise to much discussion; whilst in Chapter VII. very detailed instructions are given as to how to make a turntable for ringing slides (ordinarily bought by unambitious workers for a few shillings), to fit it with cog-wheels derived from an old egg-beater, and to make also an electric motor to drive it! About fifty pages of the book are, however, devoted to really useful elementary instructions as to collecting, preparing, and mounting objects for the microscope.—F. S. S.

Modern Theory of Physical Phenomena, by Augusto Righi. Translated from the Italian by Prof. Trowbridge. (Macmillan, 5s. net.) The mere title of this little work and the name of its author are quite sufficient to arouse an interest and to give promise of the volume being one worth careful perusal. The author describes it as "an entirely unpretentious book," but it is, nevertheless, one which will appeal to a large number of readers, and will, we feel sure, satisfy their requirements. The chapters on Electrolytic Ions and Electrons; Electrons and Light; the Cathode Rays; Ions in Gases and Solids; Radio-Activity; and the Constitution of Matter, which are described in such a pleasant, simple way, are just such as are in much request at the present time. A "bibliography," or list of papers on the subjects treated of, forms a valuable appendix.

British Bird Life, by W. Percivall Westell (London: Fisher Unwin, 1905).—The number of books which have appeared on British Birds is appalling; and of these only a very few can be regarded as really good of their kind. What excuse there can be for the appearance of the present work we fail to see.

According to the author it presents a series of popular sketches of every species of bird now regularly nesting in the British Isles. But many of the birds included in this list are all but extinct as breeding birds and are nowhere common. On the other hand, a host of birds that are plentiful enough during certain parts of the year find no place in this volume at all, simply because they do not remain to breed.

Of the numerous illustrations scattered throughout these pages we can speak favourably only of the photographs from life, some of which are very good; the original drawings are bad, without exception. Many can only be described as caricatures. W.P.P.

Six Months in the Sandwich Islands, by Isabella L. Bird (Mrs. Bishop) (London. John Murray, 1905 Popular Edition; 2s. 6d.).—This is the companion volume to "Unbeaten Tracks in Japan," and it is written in the same charming style. The first letter of the series appears to have been penned on January 19, the last on August 6, 1875. They contain vivid word pictures of earthquakes and tidal waves, human sacrifices, scenery, and domestic customs. Among the last we may specially refer to the practice of *lomi-lomi*, or massage as followed by the Hawaiians. "The first act of courtesy to a stranger in a native house is this (massage), and it is varied in many ways; now and then the patient lies face downwards, and children execute a sort of dance upon his spine!"

Keen powers of observation, and a peculiarly happy style of recording what was observed are evident in every page.

Astronomers of To-day, by Hector Macpherson, Junr. (Gall and Inglis); price 7s. 6d. net. This collection of biographies, accompanied by 27 portraits, should prove of interest to all interested in astronomy, including as it does, an account of the principal doings of many of those, foreign as well as British, of the present day who have made a name for themselves in this branch of science. The series is by no means complete, however, for such names as those of Sir W. Christie, Astronomer Royal; Professor H. H. Turner, Savilian Professor of Astronomy; Mr. W. H. Maw, President of the Royal Astronomical Society; and Mr. Crommelin, President of the B.A.A., are conspicuous in their omission, and there are others that might well have been included, but it is, of course, most difficult to decide on where to draw the line in such a list so as to include the biographies within a handy volume.

Publications of West Hendon House Observatory, Sunderland. (T. W. Backhouse.)—We have received Volume III. of the West Hendon Observatory publications, containing observations of 49 variable stars made in the years 1866—1904 by the author. In most of these observations, except in the case of T Coronæ, the variable differs much in colour from the comparison stars; this makes the probable error greater than in the case of stars of the same colour. In the catalogue given the stars are arranged in order of their Right Ascension, the positions being given for epoch 1900. Then comes the average colour and degree of redness, the spectrum type according to Krüger, and the comparison stars examined.

Pyrenean Geology. Part IV., "The Structure of the Pyrenees; Part V., "Engineering Geology in the Pyrenees;" price 6d. each part. By P. W. Stuart-Menteath, Associate of the Royal School of Mines. Eight parts in all are in preparation, the last to be entitled "The Convictions of the Monkey Mind," the connection with Pyrenean geology being at present somewhat obscure. When speaking from his own experiences in geology, the author is readable, but we cannot see the necessity of introducing into what purport to be geological works personal squabbles and acrimonious remarks concerning those who differed from the author.

A Scheme for the Promotion of Scientific Research, by Walter B. Priest (Stevens).—In this small book a project is set forth in detail whereby an inventor may obtain a public grant for the completion of his discovery. This idea in general is most desirable; but we fear that in practice there would be extreme difficulties in carrying it out. Applications are, according to this suggestion, to be referred to the Board of Trade for consideration. This department, we are inclined to think, would have to be very greatly enlarged to be able to cope with the thousands of applications that would certainly be sent in, and the amounts applied for would undoubtedly run into millions of pounds. We quite agree with the writer, supposing such a scheme could be satisfactorily arranged, in questioning "whether money so employed would not ultimately promote more effectually public interests than much of that now devoted to educational purposes which entail so great a national expenditure."

The Country Gentlemen's Estate Book, 1905. Edited by William Broomhall (The Country Gentlemen's Association, Limited; price 10s. 6d.). This is the third issue of an annual handbook which should prove of the greatest use to those owning property in the country. It gives interesting articles and information on the management of estates, farming, gardening, forestry, sport, and many other useful topics. It is a large book of over 400 pages with many illustrations.

Notes on Volumetric Analyses, by J. B. Russell, B.Sc., and A. H. Bell, B.Sc.; pp. VIII. and 94 (London: Murray; price 2s.).—This little book contains concise directions for carrying out most of the usual methods of volumetric analysis, and will be found of great use by those who have made some progress in analytical chemistry. It is a new and enlarged edition of the "Notes" published in 1898, the additional matter including various methods of standardising acids. Working details are given at some length in the earlier chapters, but are very wisely curtailed in the latter part of the book, with the object of making the student do some thinking for himself.

Elementary Experimental Chemistry, by A. E. Dunstan, B.Sc., pp. VIII. and 173 (London: Methuen; price 2s.).—If a book on chemistry is to be anything more than a collection of disjointed facts to the student each fresh step must be illustrated, as far as possible, by experimental work. This is never lost sight of by Mr. Dunstan, and almost every page of his book gives directions for simple experiments bearing upon the theory of the subject. Though primarily intended to cover the ground for such examinations as the Oxford and Cambridge Junior Locals, the Chemistry is something more than a mere "cram" book, and we can thoroughly recommend it also to beginners who have not the goal of examination before them. A small point by way of criticism is that a brief description might have been given of the bearings of the recent discoveries about radio-activity upon the atomic theory, for this is no more abstruse than many of the subjects with which the author deals so clearly.

Modern Electricity, by Henry and Hora (Hodder and Stoughton; 5s. net).—This book claims to be a practical working encyclopædia on the subject, and has been prepared with a view of meeting every emergency that might confront the electrical engineer and inventor. The object has been to simplify the information without sacrificing its clearness or accuracy, so that every apprentice and artisan will be able to gain a complete knowledge of the fundamental principles and applications of electricity. These high claims are not always justified. For example, it is not true always to say that an induced charge is equal and opposite to the inducing charge; and in the particular example given they are not equal. On page 21 a question is propounded: Two spheres charged with 4 and 6 units respectively are placed two centimetres apart. What force will they excite on each other? The question is succeeded by the following enigmatical "solution." "Any result equals the force divided by the resistance. The force is 4 multiplied by 6; therefore the resistance must be 2 multiplied by itself.

$$\frac{4 \times 6}{2 \times 2} = 6 \text{ dynes. Ans."}$$

This solution may be simple; it is certainly not clear. There is too much of this kind of thing in the book for us to be able to recommend it enthusiastically. At the same time there is a great amount of useful information gathered together here in connection with accumulators, decomposing vats, carborundum, central exchanges, Crooke's tubes, lightning arresters, lamps, cables, &c., &c.; and a large number of examples are worked out which will be useful to those who want to get at a result without caring for much refinement in the way they reach it.

The Electromagnet. Underhill (London: E. and F. N. Spon. A new and revised edition).—It is introduced by a capital portrait of Joseph Henry, of Philadelphia, who anticipated Faraday in many of his discoveries. It is an eminently practical volume, and should prove of great service as a reference book to those who are concerned in the manufacture of electromagnets. In the briefest possible space a succinct account is given of all the details which the practician can meet with in regard to choice of dimensions, wires, &c. There are a number of important tables, and also numerous problems to which answers are given. It is very neatly and carefully printed.

Elementary Plant Physiology, by D. T. Macdougal, Ph.D. (Longmans, Green, and Co., 1902. 108 illustrations. Pp. 138).—This is a useful guide in a small compass to the subject with which it deals. Some of the illustrations are very suggestive, and will be of use to the teacher of botany looking about for striking methods of treatment. The chemistry of respiration and digestion is dealt with in an interesting as well as a scientific manner.

Observation of the Total Eclipse.

The following list shows the arrangements for observing the total eclipse on August 30:—

Place.	Observers and Observatories Represented.	Plan of Work.
Labrador. (Lake Melville.)	Dr. King (Ottawa Obs.). Mr. E. W. Maunder (Greenwich). Mr. Perrine (Lick Obs.).	Search for Intramercurial planets. Large scale photographs of corona with 40′ camera.
Spain. (Burgos.)	Mr. J. Evershed.	Prismatic reflector photographs of spectrum of chromosphere and corona.
(Tortosa.)	Rev. J. S. Cortie (Stonyhurst).	
(Oropesa.)	Prof. Callendar, Prof. Fowler, Mr. Shackleton (Royal College of Science).	Experiments on coronal radiation. Photography of red and green regions of spectrum of chromosphere and corona.
	Mr. Campbell (Lick Obs.).	Search for intramercurial planets. Large scale photographs of corona with 40′ camera. Polarisation observations. Spectroscopic photography of chromosphere and corona.
Balearic Isles. (Palma.)	Sir N. Lockyer, Dr. W. J. Lockyer, Mr. C. P. Butler (Solar Physics Obs.).	Prismatic camera (3 prisms) photography of spectrum of chromosphere and corona. Large scale prismatic reflector (one prism) photography of spectrum of chromosphere and corona. Small scale photographs of corona.
(Columbretes.)	U.S. Naval Obs. German Party.	
Algeria. (Guelma.)	Mr. H. F. Newall (Cambridge). M. Trépied (Obs. of Algiers).	Spectroscopic and polariscopic observations.
Tunis. (Sfax.)	The Astronomer-Royal, Mr. F. W. Dyson, Mr. Davidson (Greenwich). M. Bigourdan (Paris).	Photographs of corona on 4″ and $1\frac{1}{4}$″ scales. Spectra of chromosphere and corona with Major Hills' spectroscopes.
Egypt. (Assuan.)	Prof. Turner (Oxford). Mr. Bellamy.	Polariscopic observations. Corona photographs with Abney doublet. Large scale photographs of corona.
	Mr. Hussy (Lick Observatory).	Search for intramercurial planets. Large scale photographs of corona with 40′ camera. Integrating spectroscope photographs.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

The Black Currant Gall-mite.

By Alice L. Embleton, B.Sc., F.L.S., &c.

This disease is caused by a creature only one-half of a millimetre in length, yet it does enormous damage. Its worm-like body has four short legs near the head, and two long tail bristles. The disease is known to gardeners as "knotting" or "knobbing," and growers are only too familiar with it; yet gardeners (especially cottage gardeners) are often the worst offenders in spreading the pest, for they propagate diseased cuttings on the ground that those particular trees produce best "fruiting buds"—which buds are precisely those that are swollen with the mites, and are worse than useless. In reality there is no difficulty in recognising infested bushes, for the buds are swollen so that they are at least three times as large as normal buds, and it is exactly this that leads to the common error of believing these identical buds to be fine "fruiting buds." While these buds are still green, with a strong magnifying glass, one can see them, when opened, to be literally a mass of the parasites. Such buds usually never open at all, but remain on the stems as brown, dry knobs; if not so badly diseased, they occasionally send out one or two feeble little leaves, but never any more. As the hold of the disease on the plant increases, the effect becomes very striking; the failure of a large number of the buds forces into premature development buds which normally would open the following year, making overdrafts in this way on the plant's vitality; after some time it is incapable of responding to these abnormal calls, for the provision for next year's foliage is already exhausted, and the plant dies.

All the winter the mites, in all stages, from the egg up to adults, are tightly shut up in the buds, and they only begin to come out in the spring—a few pioneers may even be seen as early as March, but the great host get free in May. In the severest frosts, they are unharmed in their protected quarters; in fact, they seem to revel in a hard frost, and it is indeed wonderful how their tiny bodies resist King Frost.

During their migration period, which is from the middle of May to the middle of June, they exhibit curious methods of locomotion; the four short anterior legs are ill-adapted for walking, and yet they continually crawl about at a rate of twelve to fifteen times their own length in a minute; but this only takes them from bud to bud, at the farthest; they get carried further afield by passing insects and spiders, to which they adhere first by the stickiness of their bodies, and then by coiling round a hair or antenna in a worm-like fashion, and holding on tenaciously. This can be shown by lightly touching an open, infested bud with a fine camel's hair brush, when the little white creatures will be found wriggling among the bristles, yet holding on in a determined manner. Their third method of getting about the world is the most interesting. If one watches a community of these mites in a bud under a microscope, one sees them continually standing up on their tails, waving the front legs agitatedly; then they suddenly disappear, and at first it is hard to imagine what has happened precisely. The disappearance is not so accidental as it seems; the animals are, in fact, leaping! The two tail bristles act as springs, and the mite covers about sixteen or twenty times its own length at a jump. It is always seen that after standing upright, waiting for a friendly insect to carry it off on its unsuspecting body, the mite ceases to wave its legs, remains rigid for a moment, and then launches itself forth, torpedo-like, into space. It is an entertaining spectacle to watch, for occasionally, by retaining too firm a hold on the bud, the leap is rendered abortive, and the mite simply falls backwards with considerable impetus, instead of making a clear jump. It is a suggestive fact that while the mites remain upright for minutes in the still air of a room, yet they can be induced to leap at once by blowing upon them. It seems, therefore, that they first try to get an obliging insect to carry them away, and, failing this, take advantage of a puff of air to make their blind leap. Perhaps the mite succeeds in "boarding" a passing insect which hovers near enough to fan it by the beating of its wings.

Having vacated their winter home and crawled, or been carried, or leapt to fresh pastures, the mites enter into the new young buds which are just formed, and so set up the vicious circle again. Myriads are lost, for those which fall to the ground perish, but very few are sufficient to carry on the species for the next year, for they multiply, as soon as they get into the new buds, at an amazing rate. They set up in the new buds at the beginning of June, and by the middle of the month they are all housed (or else they have perished), and the migration period is over, and of the hosts of mites which are turned loose into the world in May, only an infinitesimal number has obtained a footing in the new buds. Reproduction goes on at an almost incredible rate through July and August, and all the winter the tightly-folded buds are crowded with their unwelcome lodgers.

The question, of course, is "how can we check the ravages of these creatures?" and this can only be answered by studying their life-cycle as given above, and carefully considering at which points they are most open to successful attack. In very bad cases it certainly is best to cut down the bushes *in the winter* and burn them on the spot, for the mites are then all safely shut up in the buds, and the bushes can be dealt with in this way without any fear of spreading the pest by shaking them on to other trees, or by scattering them to the winds. Any treatment of the ground under infested bushes is practically unnecessary, as the mites do not live in the soil. As regards spraying, it is manifestly useless during the winter, when the mites are safe in the buds, and here I may call attention to a misleading statement made by the Board of Agriculture (A 1-93—1, Feb., 1893):—"Spraying. . . . in the autumn before the weather becomes cold, and just after the leaves have fallen, if possible. This will economise liquid and labour, and will affect the mites before they get into the buds." I simply quote this in case it is doing damage by being so erroneous, for the mites, as stated above, are already in the new buds in June.

The only time at which spraying can be of use is during the migration time, *i.e.*, from the middle of May to the middle of June, and then, unfortunately, it is undesirable on account of the blossom. On the whole, hand-picking is the only reliable method, and this should be done when they have got into the new buds, for then their number is reduced to a minimum, and the removal of all the new infested buds in July would apparently clear the plants of the disease. When black currants are grown extensively, hand-picking is a serious consideration, yet it is the best method that can be recommended. If this method be adopted annually the disease can be reduced to a negligible quantity within three years. The picked buds should always be burnt carefully, and not "dug in."

Cleaning Desmids.

The cleaning of Desmids is generally somewhat troublesome, and many of my readers may be glad to know of a simple method of procedure adopted by Professor G. H. Bryan, and communicated to the American "Journal of Applied Microscopy." The method to be described is particularly applicable to material obtained from mountain bogs containing submerged plants of *Sphagnum*, among which specimens of the genera *Micrasterias*, *Euastrum*, *Closterium*, *Penium*, and others abound. To collect desmids from this source, a good plan is to squeeze the *Sphagnum* into a wide-mouthed bottle, but the majority of desmid gatherings appear amenable to the same method of cleaning. The apparatus required consists of one or two shallow porcelain saucers or photographic dishes, an old pomatum pot being useful among the number, and a tapered glass tube with a rubber cap, such as a "filler" for a fountain pen. A gauze strainer for a coffee pot is useful for straining out any large pieces of dirt, the stuff left behind being examined for filamentous desmids. The strained material is run into one of the porcelain dishes, and after a short interval—not more than half a minute—the dish is inclined to one side and gently rocked. Any desmids in the gathering will be seen to collect in a bright green line, or patch, at the edge of the receding water, and can then be readily picked up with the pen-filler in an almost pure state. On working round the edge of the dish, the desmids may be drawn into green patches in almost any desired part of the vessel, and one lot after another picked up until there are none left worth troubling about. As the desmids are removed, they are transferred to the pomatum pot, where a drop of Zenker's fixative suffices to fix them. (The formula for Zenker's Fluid is $K_2\ Cr_2\ O_7$, 2.5 grms.; $Na_2\ So_4$ 1 grm.; $Hg\ Cl_2$, 5 grms; glacial acetic acid, 5 cc.; water *ad* 100 cc. Dissolve the $Hg\ Cl_2$ and $K_2\ Cr_2\ O_7$ in the water, with the aid of heat, and add the acetic acid in proper proportions as required, as it evaporates readily.) By repeating the rocking process, the desmids are again collected and transferred from the fixative to another dish containing clean water. They are deposited in a patch in the water near the edge of the dish, and by repeating the rocking, the fixative is gradually washed away, together with any remaining foreign matter. The water should be changed at least once. This method of washing involves less loss of specimens than the ordinary decantation method, provided that care is taken each time to deposit the desmids as close together as possible, for the few desmids that are not picked up in the first attempt are easily collected and picked up subsequently. The whole process takes but half an hour or an hour, so that the fixative is removed before it has time to injure the colour of the specimens.

If much foreign matter is mixed with the original gatherings, the whole may be left in a wide-mouthed bottle in the light for a day or two, when the desmids will collect on the top of the sediment, where they will increase and multiply. The surface layer, containing the desmids, may then be syphoned off and cleaned as before. Even in poor material it is often possible, by the rocking process, to collect with the pen-filler sufficient desmids to mount one or two slides. A somewhat similar rocking process is useful for separating Foraminifera from sand, but the rocking must be a little more violent, and the sand is left behind, unlike the flocculent matter in the desmid gathering, which is swept forward by the water.

To mount the desmids, Profesor G. H. Bryan takes a small piece of parchment paper, say, $1\frac{1}{2}$ by 1 inch, or less, such as is used for packing tobacco, and folds it into a little box. The water with the desmids is placed in the box, which is then floated on glycerine. In two days the water will have diffused into the glycerine, and sufficient glycerine to penetrate the desmids will have passed through the parchment into the box. The desmids are now ready for mounting in glycerine, and have undergone no contraction.

Some desmids, notably *Closterium*, have a tendency to adhere to the bottom of the dish, and then float on the water, but this tendency to float gives similar difficulties when they are washed by decantation. As species of this genus multiply rapidly by self-division, it is usually possible to start with sufficient material to allow of a small loss by flotation.

Action of Wood on Photographic Plates.

In a recent number of the proceedings of the Cambridge Philosophical Society, Professor H. Marshall Ward refers to W. J. Russell's recent memoir in the "Transactions of the Royal Society," in which is described the action of a number of different woods on a photographic plate in the dark. Russell had suggested hydrogen peroxide as the active agent, this re-agent having a definite action upon photographic plates, and the resin in the wood as probably the indirect causal agent, adducing in support the experimental result that while gum-like bodies are inactive, those of a more resinous nature are active. Professor Marshall Ward, as the result of numerous experiments, concludes that the activity is not merely due to resin or resin-like bodies, but that tannin and tannin-like bodies, as well as some others, may also be responsible. It is at least clear that some body or bodies in the liquified cell-walls reduce silver salts in the plate, and that these bodies are either shot off, as if volatile, or diffuse readily, seems clear from the want of sharpness in the microscopic details. Readers will find no difficulty in carrying out the process if they care to try it. The sensitive film of the dry plate is merely placed in contact with the smooth dry face of a wood block and left in darkness for periods of varying length, and the plate on development should show an image of the wood, knots, for instance, being particularly well marked.

[*Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for September.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.13 and sets at 6.47; on the 30th he rises at 5.50, and sets at 5.41.

The equation of time is negligible on the 1st, the Sun being only 4 seconds after the clock at noon.

Autumn commences on the 23rd, when the Sun enters the sign of Libra at 5 p.m.

Sunspots and prominences are numerous. The position of the Sun's axis and equator is as follows:—

Date.	Axis inclined from N. point.	Equator S. of Centre of disc.
Sept. 1 ..	21° 15′	7° 12′
„ 11 ..	23° 29′	7° 14′
„ 21 ..	25° 9′	7° 2′
Oct. 1 ..	26° 10′	6° 37′

THE MOON:—

Date.	Phases.	H. M.
Sept. 6 ..	☽ First Quarter	4 9 a.m.
„ 13 ..	○ Full Moon	6 10 p.m.
„ 21 ..	☾ Last Quarter	10 14 p.m.
„ 28 ..	● New Moon	10 0 p.m.
„ 1 ..	Perigee 225,000 miles	11 18 a.m.
„ 17 ..	Apogee 252,300 „	4 36 a.m.
„ 29 ..	Perigee 222,600 „	5 12 p.m.

OCCULTATIONS.—The following are the brighter stars which suffer occultation visible at Greenwich:—

Date.	Star's Name.	Mag.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p.m.		p.m.		d. h.
Sept. 4	γ Librae	4·1	7.33	85	8.37	301	5 6
„ 10	29 Capricorni ..	5·5	10.21	37	11.27	287	11 9
„ 17	μ Ceti..	4·4	10 35	42	11.36	275	18 9
„ 18	f Tauri	4·3	9.51	65	10 55	259	19 9
„ 19	γ Tauri	3·9	10 36	8	10 59	322	20 9
			a.m.		a.m.		
„ 20	α Tauri	1·1	8.24	26	9 1	322	20 20

THE PLANETS.—Mercury is a morning star in Leo; he is at greatest westerly elongation on the 15th, when he rises about 3.45 a.m. This is a favourable elongation for observation of the planet in the morning.

Venus is a morning star in Cancer and Leo; near the middle of the month the planet rises shortly after 2 a.m. On the morning of the 26th the planet will be in conjunction with Regulus, being only 16′ away to the north.

Mars is a feeble object in the S.W. evening sky, setting about 9 p.m.

Ceres is in opposition on the 4th; the magnitude of the minor planet is 7·4, but it is badly placed for observation, being low down in Aquarius.

Jupiter rises about 9.30 p.m. on the 1st and about 7.45 p.m. on the 30th. Towards the end of the month he will be the most conspicuous object in the sky, looking east about 10 p.m.

Saturn, though somewhat low down in the sky, is suitably placed for observation, being on the meridian at 10.25 p.m. on the 15th. The planet is a fairly conspicuous object in the evening sky, looking S.E., about 9 p.m., and is easily distinguished by its dull yellowish colour. As seen in the telescope, the planet always appears a beautiful object, and well repays observation. The polar diameter of the ball is 17″·4, whilst the major and minor axes of the outer ring are 43″·5 and 8″·2 respectively; thus the ring plane is inclined to our line of vision at an angle of 11°, the northern surface being visible.

Uranus is on the meridian about 6.30 p.m. on the 15th. The path of the planet lies in Sagittarius, in which constellation he will appear for several years to come. The planet is in quadrature with the Sun on the 24th, and is situated about 2½° south of the 4th magnitude star μ Sagittarii.

Neptune rises about 11 p.m. on the 15th; he is situated about 6° east of the star μ Geminorum.

Minima of Algol occur on the 8th at 10.20 p.m., and on the 11th at 7.19 p.m.

Mira Ceti is due at minimum on the 17th; magnitude about 8·5.

TELESCOPIC OBJECTS:—

Double Stars.—Polaris, mags. 2·1, 9·5; separation 18″·6. The visibility of the small star is used as a test for a good 2-inch object glass.

ζ Sagittae XIX.^{h} 45^m, N. 18° 53′, mags. 5, 10; separation 8″·6.

α^1, α^2 Capricorni XX.^{h} 12^m, S. 12° 51′, mags. α^1 4·5, α^2 3·8; naked eye double, separation 373″, very easy with opera glasses.

γ Delphini XX.^{h} 42^m, N. 15° 46′, mags. 4·1, 5·0; separation 11″·8. Very pretty double for small telescopes; brighter component yellow, the other light green.

Nebulæ, &c.—Dumb Bell nebula in Vulpecula, nearly 4° due north of γ Sagittae. Rather faint object in a 3-inch.

(M 8) Cluster in Sagittarius; large luminous field of small stars; fine object in pair of field glasses. About a degree E. of the star 4 Sagittarii.

Royal School of Mines.

THE Marquess of Londonderry, K.G. (President of the Board of Education), has appointed Mr. S. Herbert Cox to the Professorship of Mining at the Royal School of Mines, South Kensington, vacant on the death of Sir Clement le Neve Foster. In view of the changes in organisation that may be found desirable in the Royal College of Science and the Royal School of Mines after the completion of the investigations now in progress by the Departmental Committee, it has been thought best to make this appointment a temporary one. Mr. Cox is an Associate of the Royal School of Mines. After experience as Assistant Geologist and Inspector of Mines in New Zealand, he was appointed Instructor in Geology, Mineralogy, and Mines in Sydney Technical College; concurrently with his tenure of this office he was employed to give technical lectures at various mining camps in New South Wales, and practised as a Mining Engineer. Since 1890 he has been entirely engaged in private practice, and has had experience of mining in England, France, Spain, Egypt, the United States, and Canada. Mr. Cox was President of the Institution of Mining and Metallurgy in 1899-1900.

LANTERN SLIDE CABINETS.—Messrs. Flatters & Garnett, of Manchester, have just placed on the market a new form of cabinet for storing lantern slides. They are very compactly built up of various numbers of drawers, each holding 100 slides, and being without grooves damage to the binding is avoided. The cabinets are fitted in such a manner as to render the extraction and replacement of a given slide the work of a couple of seconds. The same firm also offers an improved style of "despatch box" for carrying lantern slides. These are fitted with rubber packing to prevent breakage. Both articles are very moderate in price.

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The Two New Satellites of Jupiter.

By A. C. D. CROMMELIN.

It has been my privilege to chronicle in these columns two very sensational astronomical discoveries in the last seven years. The first was the minor planet, Eros, which proved to be our closest planetary neighbour; the second was Phœbe, Saturn's ninth satellite, notable for its immense distance from its primary, and still more for its retrograde motion. The zeal and skill of American astronomers has been rewarded with three more discoveries in the satellite world during the last few months, all of which present some points of special interest.

Till 13 years ago it was entirely unsuspected that any further mysteries lay hidden in the Jovian family. The four Galilean satellites had been known for nearly three centuries, and formed a symmetrical system of worlds, comparable with our moon in size, revolving in almost circular orbits near the plane of their primary's equator. The discovery of a fifth member of the family by Prof. Barnard in 1892 excited great interest; this was a very minute world, but resembled the others in the shape and plane of its orbit. Its chief mathematical interest lay in the rapid motion of the perijove produced by its proximity to Jupiter's equatorial protuberance.

It was doubtless the discovery of Phœbe that suggested the search for very distant satellites of Jupiter, which Prof. Perrine undertook last winter with the Crossley reflector, and which proved successful beyond expectation, resulting in the discovery of two more tiny members of the system. It must be confessed that the Lick observers were somewhat tardy in distributing information on the subject to Europe, so that we were for a time in uncertainty as to whether the new worlds were really satellites, and not minor planets, which happened to be hovering in Jupiter's vicinity. However, there is now no doubt at all that VI. is a true satellite, and scarcely any doubt in the case of VII.

Dr. Frank E. Ross has deduced approximate elements of their orbits from the observations extending up to March last. As satellite VI. has been again observed at Mount Hamilton at the end of July I have used the new observations to correct his elements of this satellite, but as no recent observation of VII. has been reported, his elements are given unchanged.

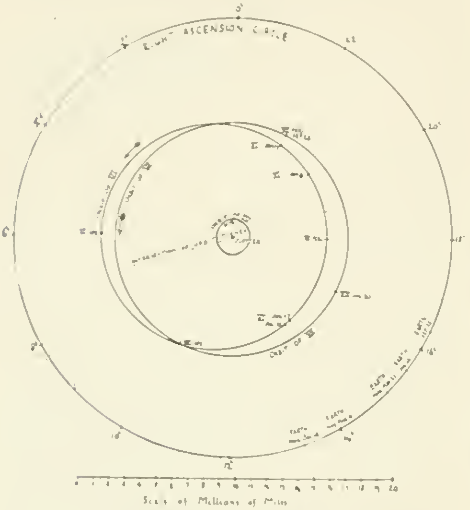
Prof. Perrine had previously announced that the motion of VII. was probably retrograde. Dr. Ross, however, finds that direct motion is much more probable, though the matter is not absolutely certain till the satellite is re-observed or till some images of it are found on Harvard photographs of the neighbourhood of Jupiter taken some years ago. Several of these photographs are available for the search.*

The most extraordinary features of these orbits are their high inclinations to both the equator and orbit of their primary and to each other. The satellites of Mars, Jupiter (5 inner), Saturn (7 inner), and Uranus (probably) move almost exactly in the equatorial plane of their primary, while our moon, Japetus, and Phœbe deviate from this towards the orbit plane of the primary. Neptune's satellite, indeed, appears to be inclined at a considerable angle to both planes, but a repetition of this anomalous feature in the hitherto symmetrical Jovian system was quite unexpected. The near approach to equality in the mean distances is also curious, and the fact that the two orbits interlock, like two links in a chain; in this respect they recall the orbits of Mars and Eros. Their great distance from Jupiter compared with the other satellites is also remarkable, and suggests that they were not original members of the system but have been added later. The capture hypothesis is attractive, but there are grave mathematical difficulties to be overcome before it can be adopted. It would seem that a planet cannot capture a body in such a way as to make it travel in a closed path round itself, but only round some other body, *e.g.*, the various members of Jupiter's comet family have been com-

SATELLITE.	VI.	VII.
Sidereal Period	$253^d.4$	$265^d.0$
Mean distance in miles.. ..	7,185,000	7,403,000
Least ,, ,, ...	6,036,000	7,221,000
Greatest ,, ,, ..	8,333,000	7,585,000
Eccentricity	0·16	0·0246
R.A. of Perijove	$269^\circ.2$	$331^\circ.28$
R.A. of Pole of Orbit Plane..	90°	$191^\circ.13$
Dec.	87°	$63^\circ.8$
Perijove Passage ..	1904 Dec 15 1905 Aug. 25	1905 Jan. 2·25 1905 Sept. 24·25
Inclination of Orbit to Jupiter's Equator..	$28^\circ.4$	$31^\circ.43$
Inclination of Orbit to Jupiter's Orbit	$26^\circ.2$	$32^\circ.0$
Inclination of Orbit planes to each other	$27^\circ.0$	
Maximum Elongation at Opposition	$77'$	$70'$
Direction of Orbital Motion	Direct	Direct
Stellar Mag.	14	16
Prob. diameter in miles ..	100	35

*Observations of VII, in August have now been reported. They confirm the direct orbital motion; but appear to show that the orbit is considerably more eccentric, and the period shorter, than the values given by Ross.

pelled by Jupiter to travel in ellipses—not, however, around the planet, but around the sun. Until, therefore, some plausible suggestion has been made of a body that could have captured these satellites, not for itself, but for Jupiter, the capture hypothesis can hardly be regarded as tenable.



Orbits of the three outermost Satellites of Jupiter.

Though the two orbits interlock, yet owing to their large mutual inclinations the satellites cannot approach each other within half a million miles or thereabouts, at which distance such tiny bodies could not perturb each other appreciably. As the nodes and perijoves are moving fairly rapidly, it is possible that after some centuries the orbits may intersect. The prospect of an actual collision is, however, very slender.

Dr. Ross calculates that the node of VII. retrogrades 1°.15 per annum, while the perijove advances 1°.45. He finds the coefficients of the annual equation, evection, variation, and principal solar perturbation in latitude to be 1°.42, 0°.38, 0°.12, and 0°.50 respectively. The corresponding quantities for VI. are considerably larger than these, owing to its greater eccentricity. When these and other perturbations have been accurately determined, the two new satellites will give a determination of the mass of Jupiter, which will be entitled to great weight.

The diagrams of the poles of the orbits, &c., are given as the simplest way of illustrating their situation relatively to the primary's equator, near which the orbits of the five inner satellites lie. Owing to the proximity of the pole of VI. to our North Pole, the satellite is nearly due east or west of Jupiter at elongation. The poles are probably moving round the pole of Jupiter's orbit as in the case of our own moon, but the time of a revolution is probably at least two centuries instead of $18\frac{1}{2}$ years.

It will be seen that the orbits of both VI. and VII. are smaller than that of Phœbe, but their angular distances at elongation are much greater, reaching to $1\frac{1}{4}°$. Their high inclinations produce most remarkable twists and curves in their apparent motions seen from the earth. A diagram is given showing their apparent places at various dates extending from December 23, 1904, to November 13, 1905. The orbit of VII. is now almost edgewise, and it must have nearly, if not quite, passed across Jupiter's disc on July 18, but so faint an object could not be seen when near its primary.

The direct motion of these satellites is unfavourable to the hypothesis suggested by Prof. W. H. Pickering to account for Phœbe's retrograde motion. According to this the planets originally rotated backwards, and very distant satellites should retain this primitive motion, while solar tides were supposed to have reversed the direction of the planet's rotation before the later satellites were born.

It can scarcely be accidental that retrograde motion exists in the families of the three outer planets, and in these only. It must be confessed, however, that Prof. Pickering's key to the enigma, which seemed so promising at first, can no longer be accepted with great confidence, though it may be possible to modify it so as to cover the new facts.

The numeration of Jupiter's family is now in a state of confusion, the order reckoning outwards from the primary being V., I., II., III., IV., VI., VII.

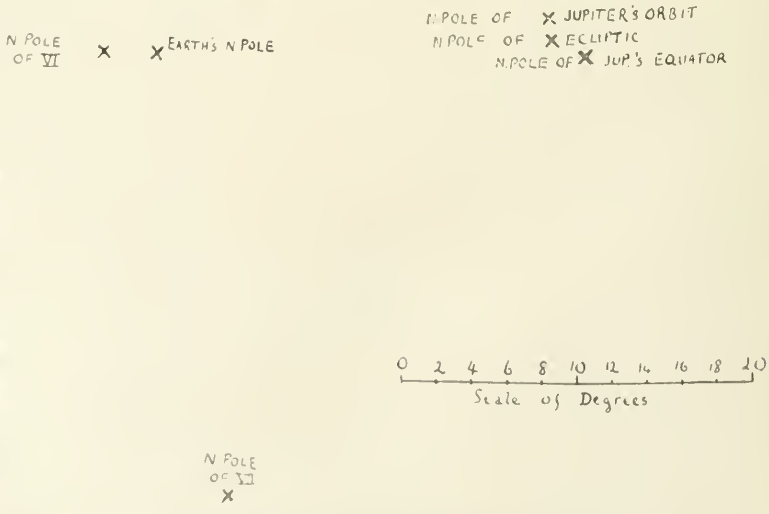
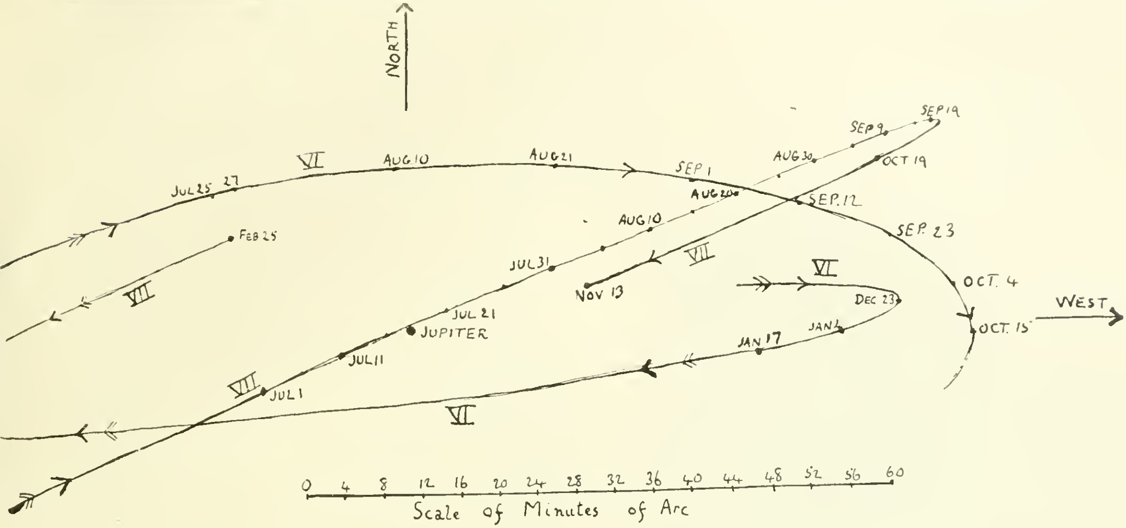


Diagram showing the Positions of the Poles of the Orbits of VI. and VII., with reference to Jupiter's Equator and Ecliptic.



Apparent Motion of VI. and VII. in 1904-5.

A similar confusion formerly prevailed in Saturn's system, and was remedied by dropping the numbers and substituting names.

The four Galilean satellites were long ago named Io, Europa, Ganymede, and Callisto. These names, however, are now seldom used. It would seem to be an appropriate time to revive them in lieu of the more prosaic numerals, and to give proper names to the three new satellites.

The tenth satellite of Saturn, recently detected on the Harvard plates, is interesting from its period being 21 days, almost the same as that of Hyperion. This presents another case of linked satellites, but in this case, unlike that of VI. and VII., the planes of motion are probably nearly identical, so that very close approaches are possible; it is rather curious that soon after the discovery of Hyperion its minuteness suggested that it might be one of a ring of satellites analogous to the zone of asteroids, an idea which R. A. Proctor endorsed in his imaginative essay, "A Voyage to the Ringed Planet." This anticipation seems worthy to rank with Swift's and Voltaire's suggestions of two Martian moons as a remarkable astronomical prophecy.

It is satisfactory to learn from a recent Harvard circular that Phœbe has again been photographed during the present apparition of Saturn, the positions agreeing so closely with those predicted from the elements given last year as to remove the smallest doubt as to the substantial accuracy of the adopted orbit.

Dr. F. E. Ross has been engaged on the study of the orbit and perturbations of Phœbe, and I understand that his researches have already been published in the Harvard Annals, but they do not seem to have arrived in England as yet. When they arrive they will be studied with great interest, as likely to throw much light on the perplexing problems which these distant satellites present to us.

Mimicry among Insects.

By Percy Collins.

It has been said that the strongest testimony to the value of warning coloration is afforded by the likeness which harmless insects sometimes bear to dangerous or noxious ones. Such instances are generally referred to as "mimicry," although the title is also (though somewhat unwisely) employed in descriptions of deceptive appearances which should really be spoken of as protective resemblance. True mimicry, according to the accepted scientific meaning of the term, consists in the external likeness of a poorly-protected creature to a well-protected one, whereby the former is enabled to share in the immunity from attack enjoyed by the latter.

Not infrequently, the young student finds some difficulty in comprehending fully the theory of mimicry, when first the subject is presented to his mind. In such cases a direct appeal to nature is usually more fruitful than abstract explanations. Let us, therefore, take an actual instance of mimicry among British insects.

The poplar clearwing (*Sesia apiformis*), in its general appearance, is exceedingly unlike a typical moth. Its wings are transparent, tinged with yellow; its thorax is brown, with a square patch of bright yellow on each side in front; its abdomen is yellow with a brown belt near the base, and another near the middle; while its legs are deep orange. It has, moreover, a general aspect of trimness and alertness very unusual among the *Lepidoptera*.

But although the poplar clearwing is unlike a moth, it is very much like a hornet. Indeed, it is doubtful whether a person unversed in the study of entomology could distinguish between the two insects merely by ocular examination. Yet a hornet and a moth belong respectively to totally distinct orders of insects; what, therefore, can be the meaning of the close external like-

ness which exists between them ? Not many years a o, entomologists—while perfectly familiar with the fact of this remarkable resemblance—were quite at a loss to account for it. To-day, in the theory of mimicry, we find a very plausible explanation of the problem.

The hornet is one of those creatures which have been provided by nature with very adequate means of

1. The Hornet (*Vespa crabro*).
2. The Poplar Clearwing (*Sesia apiformis*).

self defence. It is capable of inflicting painful and even dangerous wounds with its poison-injecting sting ; and, as a warning to its would-be assailants, the hornet has been provided (probably through the agency of natural selection) with a distinctive livery of orange and dark brown. In a former article it was shown that such a livery, possessed by a well-protected species, prevents a vast amount of unnecessary mortality because, by its means, insectivorous creatures are able to determine without "experimental tasting" what insects may be eaten with impunity. Bearing this in mind, it is not difficult to realise that a perfectly harmless insect whose colours and form agreed with those of a well-known harmful one, would be likely to share in the immunity enjoyed by its prototype. Granted that the likeness were sufficiently close, insect-eating animals would be completely deceived by it.

In the case of the *Sesia* and the hornet, there is little doubt that this is what actually occurs. The former insect flourishes on the evil reputation possessed by the latter, being mistaken for a stinging insect by the birds, which would be only too glad to eat it did they know it to be a harmless moth. A glance at the accompanying drawing from nature will give the reader an idea of how closely these two insects resemble one another in general appearance. The size and shape of its body and wings, together with the arrangement of its colours, combine to give the moth a hornet-likeness which is truly astonishing when the wide differences of structure and habits existing between the two insects is taken into account.

The order *Hymenoptera* supplies types for mimicry in many parts of the world. Indeed, it may be claimed, in a sense, that the males of the various stinging species are really mimics of the females and workers. For the drones possess no stings, and their "warning liveries" cannot, therefore, have the same direct significance which they possess in the case of the females and workers.

Species of *Hymenoptera* are constantly found to be mimicked by species of *Diptera* in a most perfect manner. Field entomologists in England will be familiar with the bee-flies (*Bombylius*) which, in their hairy covering, general appearance, and the manner in which they hover about a flower, have all the characteristics so familiar in a bee.

Species of *Hemiptera* have been found bearing a striking resemblance to ants, with which insects they company. It cannot, however, be said in what manner —if at all—the bugs are benefited by their likeness to their companions.

Here it may be said that the mere fact of one insect resembling another to a marked extent does not necessarily constitute a case of true mimicry. There is little doubt that a similarity of habitat and environment conduce, at times, to a similarity of form and colouring. Indeed, there are cases on record of insects indigenous to countries extremely remote one from another, which might well be put forward as examples of mimicry were a similarity of form and colouring the only test.

Even in the case of similarly coloured insects living in the same country and under similar conditions, the mere fact of a mutual likeness must not be regarded as proof of a mimetic relationship. The two British beetles *Triplax aenea* and *Tetratoma fungorum*, which belong, the former to the *Clavicornia* and the latter to the *Heteromera*—two widely different families—would be indistinguishable to the novice. Each has a red thorax and bluish black elytra ; each, too, may be found on fungoid growth on decaying trees. Yet, so far as the writer is aware, there is nothing known about the life histories of these insects which would justify the assumption that one is a mimic of the other. It is quite conceivable that a similarity of food, surroundings and habit may have brought about this strange likeness in colour and form. To establish a case of true mimicry it is necessary to show that one of the insects concerned—the prototype—possesses some dangerous or noxious quality which renders it dis-

Esthesia ferruginea.

tasteful to the majority of its enemies ; and that the mimicking species, by agreeing with the special type of warning coloration concerned, is able to share in the immunity.

This by way of warning to the young observer, whose enthusiasm might lead him to draw conclusions unjustifiable by fact. At the same time, it cannot be doubted that many very perfect instances of true

mimicry exist. Keeping still to the *Hymenoptera*, which on account of their stings constitute such admirable prototypes for mimicry, we find that several European beetles—such as *Emus hirtus* and *Trichius fasciatus*—have a striking bee or wasp likeness, especially when on the wing. The well-known "Wasp" beetles, too, of the genus *Clytus*, are probably to be regarded as instances of mimicry. The most interesting case of a beetle mimicking a large Hymenopterous insect, however, is perhaps that of *Esthesis ferruginea*, a representative of the *Longicornia*, from Australia. This species has the orange and black banding so commonly associated with the possession of a poisonous sting. Moreover, its elytra have become so much shortened as to be quite inconspicuous—a character very rarely seen in the group to which the insect belongs. In this way the wings, whether in use or folded above the abdomen, are fully exposed to view, just as they are in the case of a wasp or a hornet. Of course the beetle has only two flying wings, whereas Hymenopterous insects have four. This, however, is a detail which does not strike the casual observer; moreover, the wings of the beetle are proportionately broad, while there is a lobed portion of the hide margin which has much the appearance of a second pair of wings.

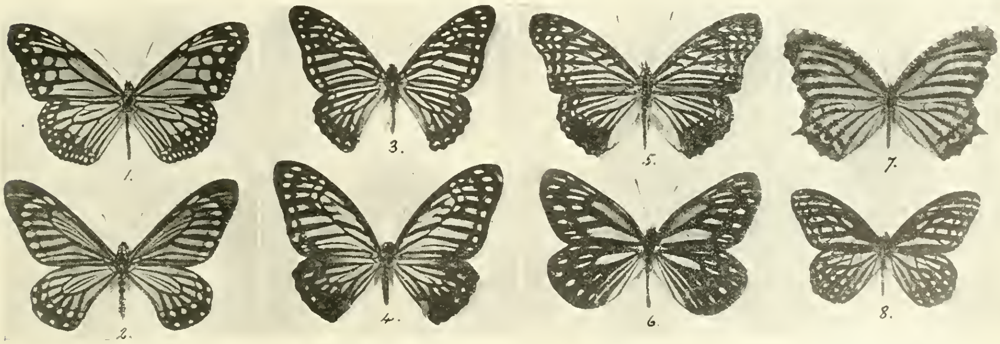
The above is an exceedingly interesting case of true mimicry; yet among the *Lepidoptera* we find numerous instances which are still more striking. No butterfly or moth possesses a sting, but many species are rendered objectionable to insectivorous creatures on account of their noxious juices; and such species are commonly found to be warningly coloured. Thus they constitute prototypes for mimicry. There is, for example, a distasteful butterfly common in the Indian region of the Eastern Hemisphere, known as *Danais melanoides*, the colour pattern of whose wings is mimicked by a number of other butterflies belonging to several distinct families, and by at least one moth. The *Danais* has pale wings, striped and bordered with black; and this design is followed, often with surprising accuracy, by its mimics. A glance at the accompanying photographs, which show *Danais melanoides* and seven of its mimics, will bring this fact home to the reader. Moreover, he will see that the seven butterflies concerned represent no less than five families, viz., *Papilionidæ*, *Nymphalidæ*, *Pieridæ*, *Elymniidæ* and *Satyridæ*.

Not infrequently, a mimicking species differs in an extraordinary degree from the typical species of the family to which it belongs. This difference is most striking, perhaps, among some of the South American butterflies—notably the genus *Dismorphia*. This genus belongs to the *Pieridæ*—a family numbering among its members all our well-known "white" butterflies. Its typical South American representatives differ comparatively little from their relatives in other parts of the world. But only an entomologist of experience would recognise *Dismorphia orise* as belonging to the same family. Indeed, it was an actual confusion of such species as this with their prototypes which suggested to the late Henry Walter

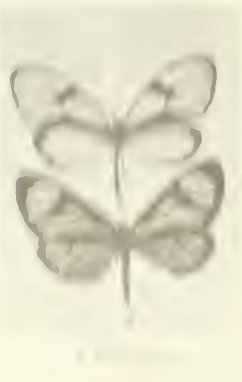
1. *Methoma confusa*.
2. *Dismorphia orise*.

Bates the train of thought which led ultimately to his suggesting the theory of mimicry. Among the butterflies which he brought home from South America there were species which, in the hurry of collecting, and packing, he had placed together; but which subsequent examination showed to be widely different in structure.

It may be asked: By what process can this insect (*D. orise*) have come to differ so remarkably from the typical members of its family, as to resemble the distasteful type represented by *Methoma confusa*? At first thought, natural selection, powerful agent though we know it to be, seems incapable of achieving such a result. But we must remember that we are looking at the work—not of tens or hundreds, but possibly of



1. *Danais melanoides*.
2. *Papilio epycides*.
3. *Papilio macareus*.
4. *Papilio xenocles*.
5. *Hestina nama*.
6. *Metaporia agathon*.
7. *Elymnias timandra*.
8. *Orinoma damaris*.



The N-Rays of Blondlot.

About the same time that these experiments were going on, M. E. Meyer noticed that plants emitted N-rays, and these proceeded from all parts of the plant. Another observer, working with M. Charpentier, noticed that stimulation of a nerve or gland increased the emission of N-rays. The emission of the rays from the heart is greater when the vagus nerve is stimulated, and the heart arrested in diastole.

Transmission of these remarkable radiations along a wire from a nerve, or other source, was observed by different experimenters, and the spinal cord was studied by means of N-rays, which were found to be given out more especially from certain portions. M. Charpentier proceeded to some still more striking speculations. He was led to inquire whether there is a specific reinforcement when there is placed near a sensorial organ or the corresponding nervous centre the physical excitant capable of acting upon them. He describes in a communication to the French Academy of Sciences, in May of last year, how he found that when a phosphorescent screen is made having for base an odoriferous substance, the luminosity of this screen is increased opposite the olfactory centres, especially near certain of them, which may be called olfactory points. Similar effects occur in the case of the organs of vision, and the related

nervous centres when a screen, with a luminous base, is used. It is inferred from the experiments: (1) That the sensorial nervous centres are specifically different; (2) that there is a certain adaptation, not only between physical agents and the sensorial agents destined to receive them, but between those agents and the nervous centres which perceive them after reception by the sensorial agent; (3) that there are certain common properties implying analogy of nature, between sensorial excitants and the peripheral or central nervous organs destined for their perception, since they show, by the sort of specific resonance referred to, analogous emissive properties.

The existence of N' rays first noticed by M. Blondlot, and referred to above, seemed to be confirmed by M. Charpentier, who published an account of some observations of his own, which showed that N' rays exert a physiological action which is the inverse of that of the N-rays. Thus, they cause a decrease of the sense of smell, instead of increasing it, as do the N-rays.

The contributions to the study of the N-rays, and the still more mysterious N' rays form, indeed, in France, a complete literature by itself. Perhaps nothing quite so extraordinary has previously been made known.

A very noteworthy fact, however, is this, that numerous practised observers, including some of the most eminent scientific men of the day, have been quite unable to observe the effects of these N-rays, even when looking for them under conditions identical with those under which they were recorded by the observers in France.

We have thus next to notice some very important criticisms upon the whole series of published facts, and especially is it necessary to consider the remarks of Dr. Lummer, the German physicist, who commented upon M. Blondlot's researches in a paper read before the German Physical Society in November, 1903.

Dr. Lummer, without wishing, in the meantime, to ous practised observers, including some of the most that a whole series of Blondlot's researches may be almost completely imitated without using any source of radiation, and that the changes in form, brightness, and colour of the surfaces observed by Blondlot may be explained by what goes on in the eye itself, and by the competition between the rods and cones of the retina in vision in the dark. Kries explained the function of the cones as being our apparatus for brightness fit for distinguishing colour, and the rods as blind to colour, and forming our apparatus adapted for darkness. Before the cones perceive coloured light, the rods produce in the brain the impression of colourless brightness. The *fovea centralis* contains cones only, while the rods predominate at the periphery of the retina. Thus, in direct vision (foveal) the rods are excluded, and only come into action in indirect (peripheral) vision. With small brightness these two portions of the visual apparatus come into sharp contest, and if the dimness is great, the colour-blind rods prevail, and everything appears grey. Dr. Lummer, in his work on "The grey glow and the red glow," explains on this theory the sudden changes which occur when a body is observed in a dark room, and its temperature steadily raised. The sudden change from dark to grey, and, again, the sudden increase from the grey glow to the red glow, are due to the successive stimulation, first, of the retinal rods, and then of the retinal cones. Shadowy vision is produced when the *fovea centralis* is not stimulated, and a sheet of heated platinum, for example, observed in the dark. A source of radiation is perceived, but not clearly seen, till the cones also are stimulated, which occurs at about 500° C. In some of Blondlot's experiments the case of the shadowy vision thus described seems to be reproduced, and the effect has been shown to an audience. A dull, glowing platinum plate is first seen by extra foveal parts of the retina. On interposing the hand or a lead screen, the gaze is limited and fixed, the foveal part of the retina is brought to bear, and the action of the rods excluded. The result is that the plate appears less bright and more red-coloured. Time and effort are required for this change, as in the experiments described by Blondlot. The phenomena are thus probably subjective to a large degree, or may be described as due to objective occurrences in the retina.

An extended series of observations were made in the physiological laboratory of the University of Glasgow with the object of confirming Blondlot's observations, but the results were uniformly negative. Prof. McKendrick and Mr. Colquhoun describe their experiments, which were carried out with the help of seven observers who were trained to accurate work. On observing a small fluorescent screen in the dark these observers noticed apparent changes of brightness when there was no contraction of muscle, and no question of N-rays reaching the fluorescent patch. When the observers were asked to look into the distance beyond the bright spot, and report on the brightness of the screens, the result was very noteworthy. They all reported, without exception, that the brightness of the screens was constant, and that muscular contraction made no difference. In this case the accommodation of the eyes for near vision was relaxed. It is suggested that there is a difficulty in accommodating for the fluorescent circle observed, and that there is a wavering movement of the ciliary muscles, and, perhaps, also a wavering in the size of the pupils. Besides this, it should be noticed that Heinrich, some time ago, found that the pupil dilates when examining an object situated in the field of indirect vision, and that it dilates still more during a short mental effort. He found also that, on directing attention to an object in the field of indirect vision, the ciliary muscle relaxes, thus diminishing the curvature of the crystalline lens, and this change is very marked during mental calculation. Prof. McKendrick suggests that the mental condition of some observers in a state of expectancy may react on the intrinsic muscles of their eyes, and thus they may see what they think they should see.

Prof. R. W. Wood, of America, when on a visit to Europe in the autumn of last year, spent some time in examining the methods of obtaining the N-rays in one of the laboratories on the Continent, where the manifestations of the new rays were announced as very distinct. He failed, however, in obtaining any evidence which satisfied him that these rays really existed. After spending some hours in watching and taking part in all the various experiments by which the properties of the N-rays are supposed to be indicated, he left the laboratory with the firm conviction that the few observers who have obtained positive results have been in some way deluded. The interposition of the hand in the path of the rays seemed to make no difference in the brilliance of a small electric spark, which was supposed to be acted upon by these rays, though, according to M. Blondlot, the cutting off from the spark of the N-rays which takes place when the hand is interposed makes a distinct difference in its brightness.

Prof. Wood regards the photographic method of showing an objective effect due to the rays to be quite illusory. The effects of refraction by an aluminium

prism he found to take place, according to his colleague working with him in a dark room, whether the prism was in position or not. A piece of wood seemed to have the same effect as a file in acting upon the retina to increase its sensitiveness to N-rays; and the removal of wood or file had no influence in stopping the apparent effects which continued to be observed by the experimenter when these exciting objects were removed. On the whole, Prof. Wood, who has himself observed and recorded so many interesting results in his experiments on light, left the laboratory, which was one of the homes of the N-rays, with the firm conviction that all the changes in distinctness of sparks, and variations in luminosity of screens by which the existence of N-rays has been thought to be proved, were purely imaginary.

Other experimenters, both in England and America, as well as in Germany, have severely criticised the methods adopted and the results obtained. No satisfactory reply to these searching criticisms has yet been forthcoming, and it would appear to be highly probable that the long series of researches carried out on these mysterious new rays must be regarded as forming a chapter in the history of human error.

The Cairo Zoological Gardens.

A LARGE number of animals have recently been added to this collection as the result of some members of the staff, including Capt. Stanley Flower, making an expedition to the Sudan. The new additions include three African elephants, 15 Sudanese lions, two addax, one Œlians wart hog, two senegal or saddle-billed storks, and six crocodiles, and amount in all to 129 animals.

Where to be Safe from Earthquakes.

By BERESFORD INGRAM, B.A., F.C.S.

THE terrible effects of the earthquake in Calabria, Italy, last month, together with the equally destructive shocks in India, and the disturbing tremors felt in Yorkshire and Lincolnshire in April last, must have caused more than one person to inquire where he must live to be safest from these calamities, against which the precautions of man are so utterly futile.

Many years ago Dr. Mallet made an exhaustive investigation of this question, and his work, when properly studied, brought to light a fact of fundamental importance to the English people, *i.e.*, No place in the world can claim an immunity from these terrestrial disturbances, but, nevertheless, *England is less liable to suffer seriously from the effects of a shock than any other European country.*

A review of the following facts, which he, and others, have formulated, will confirm the reader in the acceptance of the above gratifying assurance. Mallet prepared a map of the world, coloured so as to show where earthquake shocks had been experienced. The colour was deepened at those localities which had suffered most or had been subjected to a greater number of upheavals.

When this map was finished and studied, it revealed the following important facts:—

(1.) The bands of the darkest colour run along those mountain chains on which volcanoes occur. This would seem to suggest that volcanic eruptions and earthquake shocks had some connection.

(2.) The above bands (called "seismic bands") generally follow the lines of elevation that mark and

Within the black band earthquakes are both frequent and severe.

divide the great oceanic and terroceanic basins of the earth's surface.

(3.) Earthquakes may become visible at *any* point on the earth's surface, but the greater effects are confined to those areas in the vicinity of the lines of volcanic activity.

Prof. G. Darwin also prepared an "earthquake map," which shows (see Fig.) a broad band completely encircling the world, with which area earthquakes were both frequent and severe.

This band, as will be seen, encloses the following countries:—Southern Europe, the Mediterranean area, Asia Minor, Syria, Persia, Northern India, China, Japan, across the Pacific to Central America and the West Indies, then through the Atlantic to the Azores, Teneriffe, Portugal, Spain, and North-West Africa.

There are other Seismic bands, such as those of the Andes and the Malay Archipelago, but these may be regarded as short offshoots of the "great seismic band;" these latter, it will be noticed, are at right angles to the line of general disturbance.

If we review the list of earthquake shocks that have taken place within recent years, we shall see how they confine themselves to areas that come within the black band marked out on the map.

1868.—Peru and Ecuador. When four cities were destroyed.

1875.—San Jose (Colombia). Earthquake so sudden that the people had no time to escape, so that many thousands of lives were lost.

1903.—Turkestan. Similar disaster to that of San Jose.

1904.—Macedonia.

1905.—Albania.

1905.—Northern India, Lahore. Terrible loss of life.

It is known to everybody, that when a shock occurs in any particular locality, it develops an "earth wave," which traverses a greater or less portion of the globe according to the magnitude of the original disturbance. In fact, it is this wave which, in most cases, produces the terrible effects about which we read.

This wave travels easiest and quickest through solid rock. It has been calculated that it traverses granite at the rate of 1,665 feet per second, which is very much greater than the velocity with which sound travels.

Through shattered rock it goes at the rate of 1,306 feet per second, through slate 1,089 feet per second, and through wet sand with a velocity of 825 feet per second. The deeper the rocks are, the quicker does this wave get through them.

Of course, it travels very much slower through water.

Observations on the velocity of the sea wave, which invariably accompanies the earth wave, show that it depends upon the depth of the water through which it has to pass, going much quicker through deep water than through shallow. When it is remembered that this sea wave is some twenty feet in height, and its velocity may attain six miles a minute, it can be readily imagined that a sea coast with deep water in its immediate vicinity is not a desirable locality during an earthquake.

A very curious anomaly has been observed in the study of this subject, namely, that the region immediately above the centre of the disturbance suffers only very slightly from its effect. The seismological term for this area is the "Epicentrum."

Suppose the centre of the disturbance were twelve miles below the epicentrum (measured perpendicularly), then the region which would be most seriously affected would be twelve miles distant in any direction from the epicentrum on the surface.

Of course, the whole region is affected, but the serious effects are not apparent until a region is approached which is as far away from the epicentrum as the latter is from the internal centre.

It has been estimated that the origin of an earthquake very rarely occurs at a distance of more than 30 geographical miles below the surface, but, as has been stated before, the earth wave has practically no limit.

The surface effects of an earthquake are more destructive when it traverses soft rocks, because the cracks that are produced at the surface are kept open for a longer time, and allow the soil to slip, and the buildings to subside; whilst in the harder rocks, fissures are formed which are narrower, and will close more quickly, causing, thereby, far less displacement.

Perhaps the greatest destruction is caused when the waves travel from compact rocks to loose and soft ones. In these cases complex reflections and reverberations of the shocks ensue, producing the shivering of the surface of the land, which, of all disturbances, is the most to be feared, and the worst to be experienced. This is undoubtedly what has happened in Calabria, where the surface rocks are soft and loose, while the lower ones are hard and compact.

If the angle of emergence of the wave is small, the difficulty which the wave experiences in passing from a compact rock to an overlying soft rock is such that a very small shock is felt. This is of especial importance and interest to England, since our country is so far removed from the areas of intense seismic activity that the angle of emergence is *always* low, added to which the surface of the land is composed mostly of soft rocks; and this is the reason that, when a severe earthquake takes place in Europe or North-West Africa, it is usually felt in Scotland, where the surface is almost uniformly of solid rock; the same shock being scarcely perceptible in England.

Should the reader then live in fear of being swallowed up by the earth, and should he be fortunate enough to be able to choose any part of the world for his abode, he would have to consider (1) his proximity to either active or extinct volcano, (2) his proximity to land bounded by shores with a high gradient, (3) the nature of the strata beneath the surface, and, lastly, the distance from any other earthquake region, having a proper regard as to whether there was a relatively small depth of soft rock on a bed of granite, or other solid substratum.

The Birkbeck College, Bream's Buildings, Chancery Lane.—This Institution, which has now completed 82 years of educational work, will commence the new session on Monday, October 2nd, when the Right Hon. Sir Edward Fry will give the Opening Address, at 7.30 p.m. The Day and Evening Courses of study comprise the various branches of Natural Science (Chemistry, Physics, Botany, Zoology, Geology, etc.), Mathematics, Latin, Greek, Modern Languages, Economics, Law, Logic, and Commercial Subjects. Courses conducted by recognised teachers of the University provide for the Examinations of the University of London, in the Faculties of Arts, Science, Commerce and Law. The report for the last session shows that during the year 84 students passed some University Examinations, while a large number gained successes at various public examinations. Special classes prepare for the Conjoint Board and Civil Service Examinations.

The Total Eclipse.

Accounts from all Sources.

It had been our earnest desire to have given an account, in this number, of the general results obtained by each of the principal parties which left England for the purpose of observing the eclipse. But in some cases the observers prefer not to publish any preliminary account until their full report is presented, while others have been too busy since their return to render any narrative of their doings. The following accounts are, therefore, only a brief summary, which we hope to be able to augment in future issues.

The most westerly expeditions were stationed in Labrador, but it seems that clouds completely obstructed the view in these districts. Sir William Macgregor, the Governor of Newfoundland, was at Cartwright, where also was a party from the Lick Observatory. Another party of Canadian observers under Dr. King, was at Hamilton Inlet, and Mr. E. W. Maunder was also there.

At Burgos, in Spain, the overcast sky greatly impeded the view, but photographs of the corona were secured through rifts in the clouds.

The party at Oropesa, on the East Coast of Spain, which was under Prof. Callendar, of the Royal College of Science, was unfortunately entirely precluded from making any observations on account of the clouds.

Mr. J. Y. Buchanan, F.R.S., however, at Torreblanca, only a few miles further north, had the luck to see the eclipse in a quite clear sky. He describes the corona as being very bright, and with clearly defined edges, like fortifications. The light generally, was so great that he was unable to detect any stars except Venus. The prominences, described as of violet colour, were well seen at the beginning and end, but were not visible at the middle of totality. This should give a practical clue to the height of the prominences.

In the Balearic Islands various conditions of weather prevailed. Near Palma, the expedition from the Solar Physics Observatory had taken up a good position. The party, under Sir Norman Lockyer included Dr. J. W. S. Lockyer, Mr. C. P. Butler, Mr. Howard Payn, Mr. F. McClean, and a number of officers and men of H.M.S. "Venus." Though the weather conditions were by no means perfect, since clouds moved perpetually over the sky, yet some fairly good results were obtained with the many instruments provided.

In the centre of the town of Palma, several English astronomers, including Mr. Crommelin, had established themselves on the roof of the Grand Hotel. Here, too, clouds obstructed the view to some extent, although fairly good observations were made throughout the period of totality. But in other directions on the island, the eclipse was absolutely invisible through clouds. Shadow bands were well observed. Within a few miles of the town several observers had a clear sky.

Several British observers, unwilling to experience the mysteries of out-of-the-way Spanish hostelries, and long railway journeys, took the more comfortable, if less business-like, method of going in large steamers. Two liners, timed to be well within the limits of totality at the moment of the eclipse, had arranged to heave-to to enable passengers to have a good view of the phenomenon. In both cases the atmospheric conditions were fairly good, and if no exact or specially valuable observations were made, at all events the observers were well satisfied with what they saw. On board the "Ortona" the prominences were well seen, and described as of "rose-colour" with bases of yellow, and only noted on one side of the sun at a time. The corona, of "a soft pearly blue," had streamers projecting about two diameters, two pairs "above and below" the sun. Venus, Regulus, and Mercury were reported as being visible. The P. and O. steamship "Arcadia" also carried a party provided with small telescopes, two spectroscopes, and many cameras. The vessel hove-to near the Columbretes Rocks, south of Majorca, in perfect calm. Though clouds passed over the sun, there were intervals of perfect clearness. Baily's beads were seen, as were the shadow bands. The conclusions were that the corona was very compact, and very bright, and of a silvery hue. Only one ray stretched out conspicuously from the corona, but four or five minor streamers also existed. The prominences were said to be paler than usual. The thermometer fell from 82.4° to 72.5°.

Perfect weather seems to have prevailed at Philippeville, in Algeria, whither our Solar Physics Observatory party was originally destined to go.

At Guelma also, the conditions were most favourable. Here Mr. Newall made many successful observations with the great spectroscope from Cambridge. M. Trépied, director of the Algiers Observatory, was also installed at this place. The corona was here reported as being very bright, not extensive, and uniformly distributed round the sun. The red protuberances were well seen, as were Baily's beads. Mercury, Venus, and Regulus are reported to have been visible. Thirty-one photographs were taken by the Algiers Mission. The temperature fell during the eclipse from 33° to 28° C. Shadow bands were well observed.

At Sfax, in Tunis, was the party from Greenwich, under the Astronomer Royal, assisted by the crew of H.M.S. "Suffolk." A French party was also here, under M. Bigourdan. Though partially cloudy, the eclipse was fairly well observed and photographed. The corona, as seen here, is reported to have been of the characteristic *maximum* type, with streamers extending to as much as two diameters from the disc, and "of a rosy colour." The following account appeared in the *Times*:—

"The day of eclipse was by much the worst day that was met with. It broke cloudy, cleared a little in the forenoon, but left a nasty haze about the sun that was reinforced as the time approached by light detached clouds blowing from the north-west. The sun was never hidden for more than a few seconds, but it was unpromising for the big telescopes. As the moon crept over the sun's face the temperature, which had been at 90 deg., fell slowly to 84 deg. There was no sense of chill in the air. The party of observers was reinforced by officers and men from the *Suffolk*, told off for watching attendant phenomena, for counting seconds from a metronome, or other help. The light grew weird, and dancing bands of shadow were seen upon the ground and walls. Venus shone out, and soon afterwards Arcturus. Sir William Christie watched the diminishing crescent of the sun's disc on the ground glass of the Thompson camera, and called out "Stand by" 20 seconds before the disc should disappear. All was ready. Then occurred a delay, unaccountable at the moment, but clear enough after-

THE TOTAL ECLIPSE OF 1905.

From a drawing by Major Baden-Powell at Palma.

wards. There seemed no definite beginning to the eclipse. The crescent never wholly disappeared, or, rather, it merged into a magnificent group of prominences spread over an arc of almost 30 degrees, near the spot where the last of the sun's true disc was seen. They must have been of immense height, and it seemed at least 30 seconds before they were hidden by the advancing moon. At the same time, gradually too, emerged the corona. Observers who have seen many eclipses say it was but a poor corona. To others it did not seem so. In place of the sun's crescent, an inky black disc hung in the sky, with a great span of resy prominences east of its vertex, and at all other parts of the circumference streaks and streamers of pale but defined substances set with the strangest irr gularity, brilliant round the edge of the disc, and lost to the eye some two diameters distant. Many observers saw a rosy tint in it. Others called it a pure silver or aluminium grey. It was most unmistakably of the type associated with sun spot *maximum*. Many stars were visible, though the sky was never very dark. Too soon its 200 seconds were gone, and with amazing brilliance the sun's disc began to reappear. Nothing remained but to collect results, and to ascertain how much the indefinite beginning had spoilt the plan. It is hoped that it interfered but little. Most observers took successfully as many as seven photographs out of eight. How far the haze and diffused light of the sky may affect these can be answered only when the plates are developed at Greenwich."

In Tripoli the eclipse was observed under very favourable circumstances, as described by Prof. Todd in *Nature*. The American expedition from Amherst College set up their instruments at the British Consulate. Observation on the shadow bands were here successfully made. They were "seen as early as ten minutes before totality, and had many remarkable and pronounced peculiarities. They were wavering and narrow, moving swifter than one could walk, at right angles to the wind, their length with it, and waxing and waning five times during the eight minutes preceding totality." A disc eight inches diameter was put up at a distance of 35 feet, in order to observe the outlying streamers of the corona, but nothing was seen protruding beyond the disc. Totality, predicted to last 3m. 9s., was only 3m. 6sec. in duration. "Baily's beads" were well shown in photographs by means of an orthochromatic screen, and other photographs were successfully taken. The corona was "not impressive," being evenly developed, with no long streamers. There were also parties in Tripoli under Prof. Millesovici, of Rome, and M. Liberd, of Paris.

At Assuan, up the Nile, were stationed three national expeditions—British, American, and Russian. Prof. Turner, of Oxford, assisted by Mr. Bellamy, made special observations on the light of the corona. The *Times* reports:—"The British party, with invaluable assistance from Captain Lyons and the officers of the Survey Department, obtained five ordinary exposures with an astrographic telescope, besides one with a green colour screen and one enlargement, six photographs polarised by reflection in a horizontal plane, and two in a vertical plane. Mr. Günther, of Magdalen College, Oxford, obtained six plates with a Goerz lens for comparison with similar plates taken in Labrador. Mr. Reynolds's 120-ft. reflector was mounted under unforeseen difficulties, at short notice, with the able assistance of Mr. Keeling." The party from the Lick Observatory, under Mr. Hussy, was equipped with good photographic instruments, some being exactly similar to those used by the other party from the Lick Observatory, who were to observe the eclipse in Labrador. These two stations being situated so far apart that the times of totality differ by two and a half hours, it was hoped that any change in the corona during this period might be detected. Egyptian skies are proverbially clear, but there was a certain amount of haze over the sky, which detracted somewhat from a clear view of the corona. The change of temperature was very slight. The corona appeared small, with its longest streamer to the south-east, about two diameters or less in length, and three shorter ones.

THE SUPPLEMENT.

The coloured plate should convey to those unfamiliar with total eclipses a good idea of the general effect. It can well be supposed that it is impossible to make a really careful drawing during the three brief minutes of totality, and all that is possible is for the artist to make some rough and hurried notes, and after the event is over, to try to depict the same from memory. Under these circumstances, the details portrayed must not be taken as being exact. Photographs alone can give us the true position and dimensions of the prominences. In this case, too, the shape of the corona is not to be taken into account, for two reasons. First, in order to give some idea of the intense brilliancy of the prominences, and of the innermost part of the corona just around the moon's disc, it has been considered necessary to darken the rest of the picture. Secondly, the observations at Palma were marred by thin clouds passing in front of the eclipse, so that the fainter streamers of the corona were not visible, and only an evenly marked band of white light seen around the moon. The prominences, nevertheless, were very clearly seen through a small telescope with an 80-power eyepiece, although it is quite impossible to adequately represent in a drawing the extraordinary luminosity and splendour of these gorgeous flames.

[Just on going to press we have received an interesting account, which must be deferred till next month, from Professor Marcel Moye, of Montpellier University, who saw the eclipse very well from Alcala de Chisvert on the East Coast of Spain.]

TO THE EDITORS OF "KNOWLEDGE."

Sirs,—At Burgos last week several people, shortly after the eclipse, told me that they had seen the fourth of the five splendid prominences visible on the east limb of the sun, together with the Cromosphere between the third and fifth prominences (all counting from the top downwards) of a distinctly green colour, and it would be very interesting to know if others of your readers could confirm this observation of what would seem to have been a coronium prominence; to me they all appeared of the usual cherry-red colour, this fourth one being, perhaps, a little paler than the others.

The Corona was only faint compared to the glorious one we saw at Ovar in 1900.

Yours truly,
C. Nielsen, F.R.A.S.

Hartlepool, Sept. 9, 1905.

The Harben Lectures.

This series of lectures will be delivered at the Royal Institute of Public Health, Russell Square, by Prof. Thomas Oliver, M.A., M.D., LL.D., etc., on October 10, 12, and 17, at 5 p.m. The subject will be "Some of the maladies caused by the air we breathe in the Home, the Factory, and the Mine."

Seaweeds:
A Holiday Paper for Field Botanists.

By David W. Bevan, Scarborough F.N. Society.

III.–The Green Seaweeds.

The Green Seaweeds—last group of all that ends this strange, eventful history—the group that lends brightness and cheerfulness to the rocky pools—are closely allied to the Algæ of the pond and the ditch. In fact, some genera (*Conferva*, *Vaucheria*, and others) have representatives in both waters.

All lovers of fresh-water Algæ know these plants, *Conferva*, with its simple, unbranched row of cells, *Vaucheria*, with its branching filament of one large multi-nucleate cell. The green are the lowliest of the seaweeds. True, some plants of the red and the brown groups are equally simple in build. There is practically no difference, except colour, between the *red* Callithamnion, the *brown* Ectocarpus (a fluffy, yellow, much-branched plant, two inches high or more) and the *green Cladophora* (the common "sea moss"). In each case the filament is a simple row of cells; in each case several cells of the filament bear a branch filament, and this branching is repeated again and again (Fig. 1 shows the three plants in the order

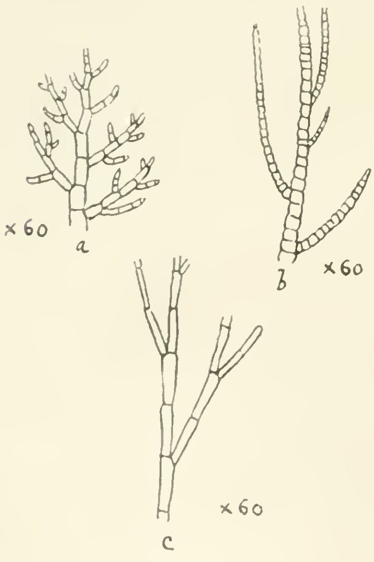


Fig. 1.

named). But the green seaweeds never attain to the complexity of structure which is seen in most of the brown and the red—the Wrack and the *Chylocladia*, to take two plants haphazard. *Ulva*, the Sea Lettuce, the queen of the green seaweeds, is a mere double sheet of cells, every one like its neighbour; *Enteromorpha*, the "sea grass," is the same thing, but is narrow and hollow—hence the name. The two layers of cells are only in contact at the edges, so that the frond is a closed tube. *Ulva* and *Enteromorpha* are shown in Fig. 2.

Moreover, it may be repeated that *the* difference between the three tribes lies in the reproductive process. So that, although the three filamentous plants mentioned above are *built* alike, we find *tetraspores* in Callithamnion, *male and female elements* in Ectocarpus, while the "sea moss" has its own special method of reproduction—a process which, once seen, can never be forgotten. Let us turn, then, to the family arrangements of the green seaweeds.

If the Sea Lettuce is gathered in summer, and a bit cut out with scissors and placed in a drop of sea water under the microscope, the protoplasm in some of the cells is often seen to be divided into, perhaps, a dozen rounded portions (Fig. 3). These are the *Zoospores*.

Fig. 2.

Fig. 3.

They are destined to be discharged, to swim away by a pair of cilia, and to grow at once into new Ulvas. There is no union of male and female. Each spore is fully endowed with the power of germination.

But to see this wonderful sight under the best conditions, *the* plant to study is the common sea moss, *Cladophora rupestris* (not a moss at all), which has comparatively enormous cells. Fresh, young, light green fronds should be selected, and a low power shows that some of the large, oblong cells have their protoplasm split up into many scores of spores. If we are lucky (or, rather, patient), we may see slight restless movements in the mass; after a while they begin to slowly slide about amongst each other, till at last the whole cell becomes a scene of wild and feverish excitement. The spores are all now in motion, hurrying hither and thither, pushing, jostling, in their attempts to find a way out (Fig. 4a). In the end, a tiny, round pore appears at the upper end of the cell (Fig. 4b), and out they all rush one by one into the microscopic ocean, put out their cilia, and start off to see life on their own account. After a while they settle down, draw in their cilia, become round—they were pear-shaped before—and begin the serious business of life; thus bringing to an end one of the most fascinating spectacles that the botanist can ever hope to gaze

upon (see Fig. 4c, which represents a group of zoospores settling on a strand of cotton-wool).

If, now, the basin of sea water, with a supply of Cladophora, is placed aside for an hour or two, a green scum appears on it. This is due to myriads of zoospores, which have come to the top, because they love the light. Pour some of the scum into a potted-meat pot, and place it in the sun. The green all assembles on the sunny side. Cover it over with a

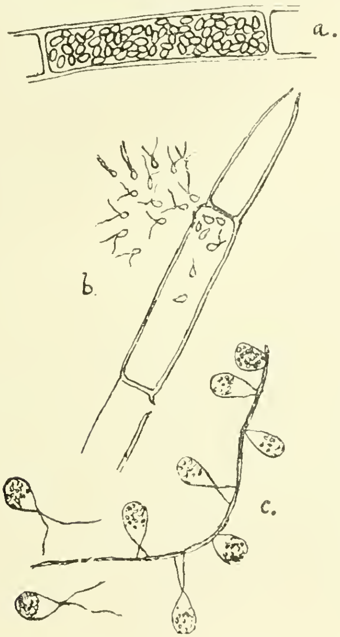


Fig. 4.

paper in which you have cut a stencil of your initials. In a few minutes, the tiny green creatures do you the honour of inscribing those illustrious letters on the watery tablet beneath. Put a drop of the scum under the microscope, and illuminate it from *below*. The zoospores are seen swimming aimlessly about in their thousands. But shut off the light below, and throw a strong light from the *side*. *Instantly* the whole crowd of zoospores turn with their pointed anterior ends to the light, and there ensues a stampede in that direction. Now examine the edge of the drop, to see what is going on at that goal to which this crowd of beings is hastening. A struggle to the death is going on. Hundreds of spores are fighting there for room—hundreds more fling themselves on the struggling mass, and numbers perish. And what we see in this tiny drop may be seen on many a fine day in summer in the pools on the shore, where the green scum collects, always densest on the edge that gets the sun.

The advantage of this love of light is obvious. If any misguided spore hated the light, it would settle in the darkest corner of the pool, and, on beginning to grow, would perish miserably from lack of that food-stuff—starch, sugar—which it is unable to work up without sunshine.

It is an exceedingly interesting fact that the brown *Ectocarpus* described above produces swimming bodies which *appear* to be identical with those of *Cladophora* (Fig. 5). But while some of these can grow at once into new plants, others unite in pairs, and, therefore, act as sexual elements. Here, therefore, we see the very beginning of that sexual process which is so marked a feature in the brown seaweeds and the red.

In Ectocarpus there is no apparent difference between the male and the female cells; but inasmuch as it is a distinct advantage for a cell from which a new generation will spring to be possessed of a store of food material, we find in the higher brown seaweeds the large, inactive female, or egg cell, which has been already described, while the male cell remains minute and active. In the red seaweeds the female organ puts out a special hair-like cell which projects into the water, and intercepts the male cell. This last is, strange to say, destitute of cilia; it is swept about in the water until by good luck, it reaches its goal.

Such are some of the delights that await the field botanist on the shore. The seaweeds appeal to his artistic, poetic, scientific, and speculative faculties. We see in them life in some of its lowliest aspects, feeling its way up to greater utility, greater beauty (which is more perfect the more it is associated with utility), and to habits and customs that make for greater success

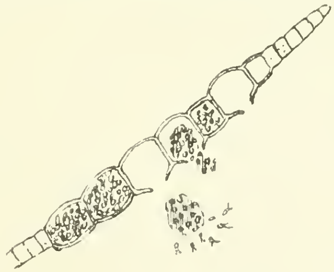


Fig. 5.

in life. Life, we repeat, at its lowest. They have no eyes, yet they see; no nerves, yet they feel; no muscles, yet they move; and they exhibit in simple fashion that passion which, in its highest exemplifications, is described as "tender." In the protoplasm of which their bodies are built reside all the possibilities of life. Our own bodies are built up of and by protoplasm; and we ourselves can do very little more than the seaweeds that dwell on our shore.

Answers to Correspondents.

Mrs. Jolly.—Reflected Sunlight.—The light of the sun, which is estimated to be some $3\frac{1}{2}$ times as bright as that of an electric arc light, is so intense that when reflected off the surface of the moon it causes the latter to "shine." Various surfaces reflect light in different degrees. Thus a window pane, even many miles away, will reflect the sun in dazzling brilliancy, and the sun shining on snow causes so great a glare as to necessitate the wearing of dark goggles.

H. Christopher.—Dark Stars.—You suggest that such bodies "belong, of course, to our solar system." We believe that no such assertion has been made by astronomers. The dark stars referred to are supposed to exist in space, but far beyond the distance at which they would reflect the sun's light. In our next issue we are hoping to insert an article by Mr. Gore, which refers to this subject.

Some New Discoveries in the Field of Radio-Activity.

By DR. ALFRED GRADENWITZ.

PERHAPS no field of modern physics is being so intensely investigated as is radio-activity, and none has gained such popularity, even with those who generally are strangers to natural philosophy. The phenomena in question, which were originally attributed only to some exceptional class of bodies, have recently been found to be common to any one of the bodies, either inorganic or organic, contained on earth.

Dr. Th. Tommasina, of Geneva, Switzerland, who is one of the pioneers in this branch of science, has lately discovered a special kind of radio-activity which he calls *pyro radio-activity*; this is the radio-active power taken by a wire charged with negative electricity, as it is heated. Such a wire will induce radio-activity in any substance submitted to its action, so that a means of activating these without the help of radium is thus forthcoming.

On continuing his researches on these lines, Dr. Tommasina, however, soon discovered a method of imparting radio-activity to a substance of any description. In fact, on account of the peculiar electric state or *ionisation*, as it is called, produced by X-rays in the surrounding medium, any substance placed in the latter will become radio-active.

It is thus sufficient to have at one's disposal any suitable outfit for generating X-rays, to impart to any substance a fairly strong radio-activity which may last for some days. Even living organisms are liable to be radio-activated without suffering any trouble, as the Rontgen rays need not strike the subject. The Röntgen bulb may, for instance, be located in a cabinet left ajar, the rays being directed towards its interior, so that the "ionisation" of the air is propagated gradually by diffusion.

This opens up a field to a possible medical application of radio-activity, which the necessity of using radium, or other radio-active bodies (exerting effects highly prejudicial to the skin), had so far prevented.

Fig. 1.

In fact, patients can now be activated without any trouble to them, and even while in bed, it being sufficient to place the latter on insulating supports, and to connect the patient to the inner armature of a Leyden jar, the outer armature of which is grounded, as is the positive terminal of the induction coil. Between the

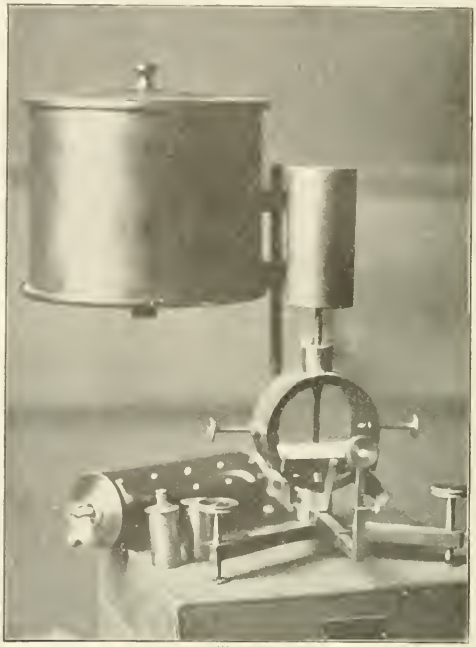


Fig. 2.

negative terminal of the induction coil and the inner armature of the Leyden jar, rapid electrical discharges are allowed to pass. By this means a fairly strong radio-activity can readily be produced.

Any solid body, both inert and organised (such as fruit, grass, and live animals), as well as any kind of conductive or insulating liquids, have thus been made radio-active. Any drugs, both for internal and external use, and any material used for bandages, compresses, etc., as well as any solid or liquid food intended for a special diet, may furthermore be radio-activated by this method without introducing any trace of radium or a similar radio-active body.

As regards the therapeutical properties of this radio-activity, nothing definite can, so far, be stated; any such phenomena are, however, found to be attended by "ionisation," which is favourable to electrolysis, and may even give rise to it. In that case a rather welcome action with a view to a rapid and complete assimilation of certain medicaments, such as iron in the cure of anaemia, might be anticipatd. Moreover, radio-activity being apparently the cause of the therapeutical properties of certain mineral waters, these may be augmented by increasing their radio-activity on the lines above mentioned.

In connection with the above experiments, Tommasina noted that, apart from the temporary radio-activity which may be imparted to animals and plants,

some of them possess a slight permanent radio-activity of their own. This is the case of any freshly-gathered plants and their parts, such as grass, fruit, flowers, and leaves, while the same plants, after being dried, show, at most, some slight traces of temporary radio-activity.

In order to ascertain whether animals also have such a permanent radio-activity of their own, Tommasina constructed a muff-shaped cage of wire grating, forming two concentrical cylinders between which an annular space of some centimetres was left free (Fig. 1). The two cylindrical wire grates were closed both at the top and below by metal discs perforated in the centre to allow of the cage being slipped readily over the insulated metal cylinder of the Elster and Geitel apparatus, serving to measure the radio-activity. On the blackened cylinder of this electroscopic outfit takes place the dispersion of electricity due to the radiation from the animals put in the cage; as the latter has the shape of a narrow circular corridor, the

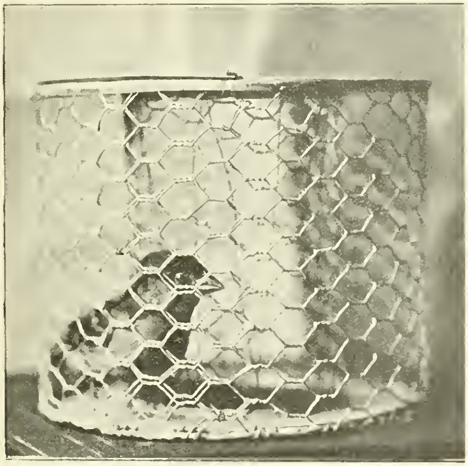


Fig. 3.

animal is allowed to move freely while remaining always at practically the same distance from the electrified dispersing cylinder (see Fig. 3). The cage containing the animal experimented on is next placed in the interior of the great cylindrical metal cylinder seen on the left of Fig. 2; this is blackened both within and without, so as to eliminate any dispersive action of ultra-violet rays.

Though these highly interesting experiments on the radio-activity of birds had to be discontinued temporarily, Dr. Tommasina was able to state that the phenomenon is quite general in character. The most interesting result is, however, that the intensity of the radio-active radiation is stronger with grown individuals than in young ones, and depends also on the state of activity or rest of the subject. In fact, *radio-activity seems to be proportional to muscular activity or vital energy.*

This phenomenon, that could be called *bioradio-activity*, has doubtless a rather intimate relation with life, and from this point of view its further investigation will probably give results of a great bearing both on philosophical and practical problems.

CORRESPONDENCE.

The Equation of Time Theory.

To the Editors of "Knowledge & Illustrated Scientific News."

Sirs,—In your number for August, a question is put to me by your reviewer in his observation upon the first part of my work, "Some Elements of the Universe Hitherto Unexplained." I am sure you will permit me to reply, the more especially as the question of your reviewer raises an interesting issue upon the subject. The question has relation to Chapter IV., which asserts that the existing theories do not account for the cause of the sun's irregularity in time, and furnishing a new explanation. The question of your reviewer is —"How would he deal with an obliquity of 90°?"—meaning, I suppose, if the obliquity of the ecliptic were 90°, instead of as at present 23° 27′ 5″·92. To answer this it is necessary to use the reputed effect of the present obliquity as the basis for gauging the effect at 90°. To limit my reply as much as possible, I will confine my remarks to the 30° immediately following the March equinox. The advantage of taking these 30° is that the theoretical causes of the sun's irregularity are here all acting in the same direction, if they act at all; and the sun is at its average distance, the actual mean occurring on April 1. If a celestial globe be referred to, it will be seen that the distance along the ecliptic from the equinox to meridian 30 is just over 32 degrees of arc, or 2° more than along the equator. If the obliquity were increased to an angle of 45°, it will be found that 8° is added before the 30th meridian is reached. At an angle of 70° the extra distance is 27°; at 80° it is 41°; at 85° it is 50°; and at 90°, to make up the full arc of 90°, it is evident that 60° is required. Traced in this way, it is seen that if the present obliquity has an effect, the increase would continue up to 90°; it would then decrease in the same ratio. What then would be the result of moving the ecliptic the extreme limit of 90° from the equator, or at right angles to the equator? At the equinoxes the axis of the earth would be parallel to the equator. Still there would be 12 hours day and 12 hours night, just as now. But at the December solstice the south pole of the earth would point to the sun, and at the June solstice, the north pole on June 21, the sun would be almost stationary in the mid-heavens. But it would begin a small spiral, and by noon next day would cross the 180th meridian about one degree from the north pole. The following day it would apparently describe a slightly larger spiral, and continue to increase the spiral day by day, and also to cross the 180th meridian with an advance at the same rate that it now moves along the ecliptic. As the obliquity of 90° results in this small circle in the sky at the solstice (during which the sun will pass over less than 6° of arc), will it occupy a less period of time than the circle twice the size next day, or any of the increased circles up to the time of the sun reaching the equator and passing round the whole 360°—or more than 60 times the arc distance of the small circle. It is evident that all will occupy the same time, because the sun does not move, but the appearance of its movement is due to the revolution of the earth, and no variation can be detected in that. It is thus seen what a valuable argument the question of your reviewer supplies against the existing theories, because the placing of the ecliptic at right angles to the equator not only shows that at the greatest possible angle no difference is made in the causes said to produce the sun's irregularity; but by removing the effect of the earth's revolution in its orbit from the effect of its revolution on its axis, it is made plain that although the sun would appear to move from the south pole to the north pole in the course of six months (or nearly nine times its present change of altitude), yet it would not entail any difference in time because it must be performed in the period of the earth's revolution on its axis. The irregularity in the sun's motion, due to causes which I explain in my work, would not be affected by the change of obliquity, and would be indicated by a variation in its latitude. If the Cæsar of obliquity be appealed to, let the decision be according to what is claimed. In the period the sun ought to move from the equinox to meridian 30; if its motion be measured along the line of the ecliptic, it must be more than 2° behind time. Two degrees means nearly two days, or 1 hour 36 minutes per day.

That is, the amount of obliquity causes the sun to be slow, or it has no effect. Can anyone explain away these two days if they exist or show that any cause is operating to reduce them? I would like to touch upon other points, but fear I have exceeded allowable limits.

August 17, 1905. A. Balding.

By the courtesy of the Editor I have seen Mr. Balding's letter, and I at once admit that my supposed challenge was a little hasty, since an obliquity of 90° is a sort of paradox, and its effect would be less obvious than that of an obliquity of *nearly* 90°. Apparently, however, Mr. Balding fully realises the sort of effect to be expected. The appeal to Cæsar may stand, and we may admit the approximate accuracy of the 2°. But two degrees will not mean two days, as Mr. Balding imagines, since, as he himself allows, the motion is not that of the sun but of the earth, so 2° means about 8 minutes of time, or 16 seconds (roughly) per day. A very different matter to his 1 hour 36 minutes.—The Reviewer.

Eoliths.

To the Editors of "Knowledge & Illustrated Scientific News."

Sirs,—A recent experiment in France is reported whereby so-called Eoliths were produced by mechanical means; the impression caused by the report is likely to lead to some discussion on the nature of Eoliths. It appears that certain French authorities visited a cement factory at Mantes for the purpose of examining certain stones chipped during some mechanical process whereby flints are separated from the chalk matrix. At the conclusion of the process they were astonished to find "that the great majority presented examples of all the Eolithic forms." On this point of similarity it is necessary to suspend opinion, but the observers have, as a result abandoned all conviction that Eoliths had an artificial origin. No one doubts that stones somewhat resembling Eoliths can be produced by natural processes—the Mantes process it should be borne in mind is not a natural one—but at the same time there is a distinction to be drawn between them and true Eoliths. Again, with all respect to Continental observers, it may be said that much of what is there accepted as of human origin would here be rejected as too indefinite. In what way it can be shown that the Mantes mechanical process resembles the action of the rivers in depositing the plateau or any other gravels is difficult to understand. We are told that the flints and the containing chalk blocks are placed in a receiver full of water, and then rotated to effect separation; but here is no parallel of action, as in the separating process the materials are strictly confined within the receiver. We are further informed that the majority of flints thus separated show work of seeming Eolithic type. In this feature the plateau gravel compares unfavourably with the Mantes process, for in the former the worked stones form but a small proportion of the whole. It should be remarked that unrolled Eoliths often occur with rolled flints, and that the clayey nature of some plateau gravels preclude the necessity of supposing a violent type of deposition; in fact, the presence of this clay serves to show that in some cases deposition went on in a tranquil manner, or under circumstances not favourable to the abrasion of flints. How, it may be asked, can the presence of *unrolled* Eoliths in this clayey drift be explained away other than by suggesting that they were dropped near these ancient streams and subsequently covered by the containing clay?

Under any circumstances the Mantes pseudo Eoliths do not dispose of the evolutionary contention for a period when man had not arrived at the Paleolithic stage of his culture. Professor Boule and Dr. Obermaier will shortly discuss these pseudo-Eoliths, when they will doubtless give reasons for the contention that a modern mechanical process can be admitted as evidence against the human origin of Eoliths.

That natural agents can fracture flints is admitted, but the nature of the fracturing may be said to bear with it its own explanation; another explanation is demanded by the definite types of Eolithic implements. For this reason, then, all students of these early forms will await with interest the advent of these pseudo Eoliths from the Mantes cement yards.

Chelsfield, Kent, Yours faithfully,

August 17, 1905. J. Russell Larkby.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Sensitisers.—The action of certain dyes and similar organic substances as sensitisers for photographic plates, especially for conferring increased sensitiveness to green and red light, is so well known that it is interesting to note the effect of similar bodies when added to other light-sensitive substances. Messrs. H. Calmels and L. P. Clerc (*Le Mon. de la Phot.*, July; Abstract, *Jnl. Royal Phot. Soc.*, August) have experimented in this direction with bichromated gelatine and albumen, as used in photo-mechanical work (making process blocks). One sample of erythrosin doubled the sensitiveness of a gelatine film, another increased it to three times, while a sample of eosin made it four times as sensitive as when untreated. From two to four grams of the colouring matter to each litre of the prepared bichromated solution of gelatine or albumen is about the maximum quantity, and when more than this is added the sensitiveness of the resulting film is decreased. Messrs. A. Jodlbauer and H. V. Tappeiner (*Ber.* p. 2602; Abstract, *Jnl. Soc. Chem. Ind.*, p. 903) find that the sensitiveness to light of a solution of mercuric chloride and ammonium oxalate (as used in photometry) is increased by the addition to it of certain fluorescent substances, including fluorescein and its chlorine, bromine, and iodine derivatives. It would be interesting to know the character of the added sensitiveness in these cases, whether the substances used are "colour sensitisers," as the expression is used in relation to gelatine and collodion plates. But, in any case, until it is shown to be otherwise, a broad distinction must be made between the effects just referred to and the sensitising of silver salts, because, in the one case, it is a definite chemical change that is quickened, while in the other the change is presumably not chemical at all, though, further than this, nothing is known of its real nature.

The Principles of Development, etc.—The recent communications of Messrs. Sheppard and Mees deal with matters that have an important bearing upon photographic procedure, and from them I have gathered the following results and conclusions. It must not be supposed that these results can be applied without modification to all circumstances that appear to be similar to those stated, as investigators cannot be held responsible for the modifications that plate-makers may see fit to introduce into their formulae, or photographers into their methods. The plates used were, I believe, specially prepared by coating plate glass with a simple emulsion containing less than one per cent. of silver iodide, and the minimum of soluble salts.

The quantity of silver that is found in 100 square centimetres of film after exposure and development to give a "density" (opacity logarithm) of unity, the authors find to be .01031 gram as a mean of several experiments. Eder had previously obtained the same figure, but Hurter and Driffield found .0121, and subsequently, .0131 gram. The authors suggest that this discrepancy is due either to a constant error in Hurter and Driffield's photometer, or else to the plates used. I believe that it is a common experience with plate-makers that very much more silver is necessary to give density in a quick plate than in a slow one. From this, and other considerations, I should have expected

this figure to vary considerably, according to the character of the plate.

The discrepancies obtained in the results of measuring plates similarly exposed and developed gave in three series of experiments 3.2, 2.2, and 6.0 per cent. as the greatest deviations from the mean density in each case. These errors, due to the plates, were obtained by the use of an emulsion specially coated on to plate glass, but not by means of the apparatus the authors have since constructed for coating experimental plates.

Concerning the velocity of development with ferrous oxalate, the authors find that (1) the silver is deposited at first with increasing rapidity, then more slowly, tending to a limit that depends only on the exposure, (2) the velocity is proportional to the concentration of the developer, but that this relationship is liable to be interfered with by the accumulation of the products of the reaction in the film, (3) a soluble bromide reduces the velocity, but the reduction becomes less as the action proceeds, (4) as the bromide is increased in geometrical proportion the velocity diminishes in arithmetical proportion, (5) hardening the film is without effect on the velocity of either developing or fixing, even when a four per cent. solution of formaldehyde was applied until the film was insoluble in cold water, (6) the velocity of development varies with different plates, and diminishes for a given plate as it gets older, (7) the velocity depends mainly on the rate of diffusion of the developer.

Concerning the grains of silver and their disposition in the film, the authors find that (1) by short development the depth to which the image extends is independent of the exposure (I suppose in the absence of soluble bromides), but that finally it becomes a maximum for each exposure; (2) by exposing through the glass, still the grains most exposed begin to develop first; (3) the size of the grains increases during development until finally it is independent of the exposure; (4) the addition of bromide causes a diminution in the size of the grains.

Many of these conclusions are in full agreement with the everyday observations of photographers, and the results of previous investigators. It will, however, doubtless surprise many to learn that the velocity of development and fixing is not affected by the hardening of the film.

Mr. Sheppard has also published in the Journal of the Chemical Society for August a communication on development as a reversible reaction, and on the retarding action of soluble bromides. I have refrained from referring to anything stated therein, because, as the author says that it bears on many points in photographic practice, he will, doubtless, shortly indicate its practical importance himself. But I would remark on the fact that in using the word "reversible," he does not appear to consider the difference between developable and non-developable silver bromide. The silver bromide is reduced by the developer, because it is in the developable condition, undevelopable silver bromide not being reducible under the same conditions. When the reaction is reversed, the resulting silver bromide would, I suppose, not be likely to be in the developable state.

The Royal Photographic Society.

The annual exhibition of photographs was opened on the 20th of September at the New Gallery Regent Street, and will remain open until October 28th. The large collection will be found of considerable interest to photographers. Amongst other items of scientific interest are some fine specimens of X-ray work, and some examples of three-colour printing.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Nova Aquilae. No. 2.

In a telegram circulated from the Kiel Centralstelle, Professor Pickering announced that Mrs. Fleming had discovered a new star from examination of plates obtained at the Harvard College Observatory. The star was situated near λ Aquilae, and was stated to be fading rapidly at the time of discovery, September 1.

The position first circulated was

$$\text{R.A.} = 284^\circ\ 2' = 18^h\ 56{\cdot}1^m.$$
$$\text{Decl.} = -\ 4^\circ\ 34';$$

but a later wire gave a more accurate value of the right ascension as R.A. = $18^h\ 57^m\ 8^s$.

By September 4 several visual observations had been made. Professor Max Wolf reported that at Heidelberg the star was observed on September 4, the magnitude being then about 9·3. The position was determined to be:—

R.A. = $18^h\ 54^m\ 24^s$ (Epoch 1855).
Decl. = $-\ 4^h\ 39^m$ 1905, Sept., $4^d\ 9^h\ 30^m$ Koenigstuhl Mean Time.

On September 6, Dr. P. Guthnick telephoned that he had been able to observe the new star at the Bothkamp Observatory, and giving its position to be:—

R.A.	Decl.	Epoch.
H. M. S.	° '	
18 54 25	− 4 38·8	1855·0
18 57 4	− 4 34·8	1905·0

The magnitude on September 5 was about 10·2, and the colour greenish yellow.

Beginning of the New North Polar Cap of Mars.

An interesting observation was made at the Lowell Observatory, Flagstaff, Arizona, on May 19, 1905, which determined the important fact of the definite time of formation of the new north polar cap of the planet Mars. A large white patch was first noticed south and west of the old polar cap, and it was quite certain that nothing of the kind was visible the day before. The season would correspond to that about August 20 with us. In extent the area of the new patch was enormous. On the 20th the white patch was again visible and showed a brilliant kernel at its southern end in longitude ± 70°.

The date of this formation was 126 days after the summer solstice of the Martian Northern Hemisphere, and it is very important to note the agreement of this value with that first determined in 1903, which was given at 128 or 129 days after the northern solstice, as this shows evidence of constancy of meteorological cycles on the planetary surface.

Further Observations of Jupiter's Seventh Satellite.

From a telegram circulated by the Kiel Centralstelle, we learn that Professor Albrecht has obtained another determination of the seventh satellite of Jupiter, with the Crossley Reflector of the Lick Observatory, as follows:—

	Position Angle.	Distance.
1905, Aug. 7 96 G.M.T. ..	289°·7 ..	54′ 6

In the Lick Observatory Bulletin, No. 82, a set of elements for the satellite are given by F. E. Ross, computed from the observations by Perrine, on January 3, February 8, and March 6, 1905.

ECLIPTIC ELEMENTS

Mean Jovicentric Longitude at Epoch	..	333·55	1905. Jan. 0·0 G.M.T.
Longitude of Perijove	.. .. ..	336·65	
Longitude of Node	.. ..	237·23	
Inclination to Ecliptic	.. .. ..	31·[illegible]	
Inclination to Jupiter's Orbit	.. ..	32·0	
Longitude of Node on Jupiter's Orbit	..	238·6	

ELEMENTS REFERRED TO EARTH'S EQUATOR.

Mean Jovicentric Right Ascension	..	3[illegible]·15	1905. Jan. 0·0 G.M.T.
Right Ascension of Perijove	.. ..	131·28	
Right Ascension of Node	..	251·13	
Inclination to Equator	.. .	26·2	
Mean daily motion		1·358	
Log. a		8·0004	
a		52·54	
e		0·0246	
Period		265·0 days.	
Distance at maximum elongation		70'.	

It is thought that the combined observations of the sixth and seventh satellites will furnish material for a new determination of the mass of Jupiter, which should be comparable in accuracy with the best results hitherto obtained.

EPHEMERIS FOR OBSERVATIONS OF JUPITER'S SEVENTH SATELLITE

Greenwich Mean Noon.	Position Angle. °	Distance '
1905 October 4	290	59
9	289	58
14	289	55
19	288	51
24	287	46
29	287	40
November 3	285	33
8	284	26
13	283	18

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Commercial Phosphorus Sulphide.

The terrible effects, notably the decay of the jaw bone, produced by the ordinary white phosphorus upon the workpeople in the match factories have led to many attempts being made to find a satisfactory substitute. The red modification of phosphorus is non poisonous, and does not produce the physiological effects of white phosphorus, but has the drawback of not being ignited by friction, while the scarlet modification discovered by Dr. Schenck has not yet come into general use, although it appears to be non-poisonous and yet chemically active. In the national match factories in France a sulphide of phosphorus has been used for several years for the tips of matches that will strike anywhere; and it is stated that the disease is now unknown there. It is most essential, however, that the sulphide should be quite free from white phosphorus, and M. Leo Vignon has therefore made experiments as to the best means of detecting it. He finds that the commercial product usually consists almost entirely of phosphorus sulphide, P_4S_3, and contains about 1 per cent. of free phosphorus, which is of the red modification, and therefore harmless. The only test that gives satisfactory results is to pass a current of hydrogen over the product, when in the presence of white phosphorus the gas becomes phosphorescent in the dark, and will burn with a green flame, yielding phosphoric acid, which can be identified by well-known tests.

An Anti-Serum for Hay Fever.

The hay fever of Europe is now well known, caused by the pollen of a large number of plants—notably grasses, while the widespread and more [illegible] "autumnal cold" of North America has been traced to the pollen of the rag weed (*Ambrosia*), and also of certain asters and chrysanthemums. The whole question has been thoroughly investigated by Professor Dunbar, of the Hygienic Institute of Hamburg, and a simple method of serum treatment devised. A substance of an albuminous character could be isolated from each of the active pollens by extraction and precipitation with alcohol and salt, and this substance produced all the symptoms of hay fever in susceptible individuals. Unlike the true toxines produced by many pathogenic bacteria, it was not destroyed by heat, and could also resist the action of dilute acids and of the ferments of the digestion, though it was sensitive to the action of alkalies. Different individuals varied as regards their susceptibility to its action; but as a rule a dose of $\frac{1}{1000}$ to $\frac{1}{2000}$ of a milligramme was sufficient to produce all the local toxic effects. An anti-serum was obtained by inoculating rabbits with this preparation, and the immunised serum thus prepared neutralised the poison outside the body, and in practice protected susceptible subjects against the pollen. It is now sold as a commercial preparation under the name of *pollantin*, either in the liquid state or in the form of a powder, obtained by evaporating the serum in a vacuum. It is only intended for external application, for although subcutaneous injection does afford some protection, the immunity is only partial, and does not last more than a few days at most.

The Composition of Soot.

Mr. E. Knecht has examined numerous specimens of soot of various origin, and especially that from the Manchester chimneys. This was found to contain about 11 per cent. of ammonium sulphate, 20 per cent. of other mineral matter (ash), and 13 per cent. of substances soluble in benzene, the residue (46 per cent.) being assumed to be carbon. The substances soluble in benzene were hydrocarbons of high boiling point, while the insoluble residue was a brownish highly inflammable powder, taking fire spontaneously when heated to the temperature of boiling water. Extraction of the soot with alkali yielded a brown product, from which a dyestuff could be prepared, giving fast shades on cotton, ranging from fawn to dark brown. London soot contained a very much smaller amount (1·3 per cent.) of substances soluble in benzene, while soot from Prague (lignite coal) yielded only 0·2 per cent. of these substances and contained only traces of ammonia.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Niagara's Horse-power.

According to a recent survey of United States engineers, the Niagara River in its course from Lake Erie to Lake Ontario falls a distance of 327 feet, and discharges 230,000 cubic feet of water per second from one lake to the other. At the same time it develops an equivalent of about 9 million theoretical horse-power, of which 50 per cent. is estimated to be available for industrial purposes.

Glaciation of Turkestan.

Evidence of the extension of what we know as the Glacial Period accumulates. Mr. Ellsworth Huntingdon, in "Explorations in Turkestan" (Washington), claims for the neighbourhood of his explorations as many as six advances and six interglacial withdrawals of the ice, basing his claim on the phenomena exhibited by those valleys which still contain glaciers in them. The idea that the Glacial Period was confined to any one portion of the globe is vanishing before the advance of geological science, and Croll's so-called astronomical theory no longer gives an acceptable explanation of the phenomena of the age.

Black Gault.

In the process of excavating for drainage in the village of Ditchling, in Sussex, three pits have been dug to a considerable depth, each pit being separated from the next by about 200 yards. At a depth of 10 feet, black carbonaceous clay has been reached, so thickly impregnated with black vegetable matter as to constitute a soft lignite. The base has not been reached, but it extends to at least a thickness of 15 feet. The village is situated about a mile north of the chalk escarpment, and the outcrop of the gault clay is midway between the hills and the village. The black mud is covered with what is probably the wash of the lower greensand beds of the higher ground somewhat farther to the north, and no doubt represents a basement-bed of the gault clay. It promises to yield a large quantity of water, should it at any time be necessary to utilise it for the purpose.

White Tertiary Limestone at Herne Hill.

In my collection are some pieces of hard white limestone which I collected some time ago in what is now the end of Rosendale Road, Herne Hill, when excavations were being made for house-foundations. Tertiary limestones are, of course, not unknown in our country, the Isle of Wight Oligocene beds being instances. I do not remember, however, having seen any reference to Eocene limestone in the neighbourhood in question, and the point seems to be worthy of record. Some of the rock was so hard as to have necessitated the use of the pick and crowbar in its excavation, and resembled the "Chalk Rock." Some portions were to some extent siliceous, whilst others bore a close resemblance to ordinary chalk. The stratum was fairly extensive, and, so far as one can judge from the work of the Geological Surveyors, it probably forms a stratum of the Woolwich and Reading series.

Mammals in the Wandle Valley.

Amongst the Mitcham gravels the following Pleistocene remains have been found, and are to be seen in the Croydon Town Hall: Tooth of Mammoth Calf (*Elephas primigenius*); tusk of ditto; bones of *Bos primigenius*; bones of horse (*Equus caballus*). In the Thornton Heath gravels have been found five teeth and numerous fragments of bones of *Elephas primigenius*. These are preserved in the Grange Wood Museum, together with 5 feet of a tusk from the Mitcham gravels.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Bird Outlaws in Norway.

Birds of prey in Norway are apparently kept under with a stern hand. The *Field* of August 26 contains a list of carnivorous mammals and birds upon whose heads a price is set by the Government. Last year head-money was paid for 108 eagles, 130 eagle owls, 93 gyr-falcons and peregrines, 437 goshawks, 880 sparrow-hawks, and 1034 divers. We cannot congratulate the Norwegians on the war of speedy extermination which they are prosecuting.

Montagu's Harrier in Northumberland.

Mr. Abel Chapman, in the *Field* of September 2, writes to protest against the "brutal and selfish" destruction of a Montagu's Harrier (*Circus cineraceus*) on the Moors of Coquetdale, Northumberland, in August last. This bird, a female, had apparently haunted these moors for some weeks only to be shot at last by a gamekeeper. Mr. Chapman writes with some warmth on the matter, and we most heartily endorse his remarks.

Hen Harrier in Norfolk.

A male and female hen harrier (*Circus cyaneus*) were shot (*Field*, September 9) "during the last few months—the one at Snettisham, the other at Wolferton—while quartering the marshes." Both were immature birds.

White Stork in Norfolk.

The *Field* of September 9 records the occurrence of a white stork (*Ciconia alba*) at North Wotton. Of course the bird was shot, and proved to be an adult male in full plumage.

Great Snipe in Shropshire.

An immature specimen of this species is recorded by Mr. E. G. Potter in the *Field* of September 9 as having been shot at Prees, near Whitchurch, Salop. The sex of the bird is not stated, but the weight was $6\frac{3}{4}$ ozs.

Dusky Redshank in Kent.

The *Zoologist* for September records the shooting of a pair of Dusky Redshanks (*Totanus fuscus*) at Jury's Gapp, Lydd, on May 29, both birds being in summer plumage.

Squacco Heron in Kent.

A specimen, fully adult (sex not stated), was shot in a grass field at Rye, Sussex, according to the *Zoologist* for September, on June 3. This makes the forty-first authenticated occurrence of the species in Great Britain.

PHYSICAL.

By Alfred W. Porter, B.Sc.

An Electrical Experiment.

Professor Worthington, of the Royal Naval Engineering College, Devonport, has recently tested whether any difference can be detected between space which is at a high electric potential and space at a low potential quite irrespective of the existence of any electric field in the space in question. In explanation of this last proviso we may remind the reader that electric force arises whenever there is a difference of potential between two points; so that the absence of electric force implies that the experiment must be so performed that the electric potential has a uniform value. Use is made of the fact that the potential inside a closed conductor is uniform. Two such conductors, consisting of long tubes of semi-circular section, were placed with their flat sides separated by a sheet of ebonite only. These tubes were connected to the knobs of a Wimshurst machine, and when the machine was excited the space inside one of them would take a high positive potential —practically uniform throughout it—whereas the other space would have a much lower (or negative) uniform potential. The experiment consisted in looking for a possible effect of the potential upon the velocity of light. An ordinary interference device was employed, *i.e.*, light from a single source was split into two beams, one of which passed down one tube, the second down the other. These beams were then brought together again by a telescope lens, and in the overlapping region interference bands are observed. If the effect of the high potential is to increase the velocity of light then these bands will shift. "When care was taken not to touch either table, no shift whatever could be detected either when the spark occurred or while the potential difference was accumulating." The spark referred to was at the adjustable knobs of the machine, which were kept $1\frac{1}{4}$ inches apart. This distance determined the maximum difference of potential, viz., 60,000 volts; the length of the tubes was 152 cms. Assuming that a shift equal to one-twentieth of a band could have been detected if it had occurred, it follows from its absence that if there is a difference of velocity it is less than $\frac{1}{53}$rd of one-millionth of the velocity itself.

Ether-drift.

Prof. Brace has recently extended the tests on a possible influence of ether-drift on rotary polarisation using oil of carraway seed instead of quartz, and concludes that the effect of the motion of the earth on the rotation in active substances is certainly less than one part in five million, and probably less than one part in ten million of the total rotation.

The Future of Science.

In an interesting article in the July number of the "Popular Science Monthly," Professor Dolbear asks, "Is there no more work for the man of science? Are there no more problems of importance awaiting the investigator? Have we all the knowledge we are likely to get? There are some who, having noted the prodigious product of the nineteenth century, have half feared that science has been worked out." We would point out that a glance at almost any scientific journal should act as a tonic to any one who may be taking a depressed view of the situation. It is not a distant retrospect that we must make in order to reach a period of scientific prosperity. There probably never was a time in which greater advances were being made than the present. Professor Dolbear, however, is not himself a pessimist. He asks the question merely as a preface to some suggestions of his own as to future lines of research. We select one paragraph only: "When the ether is understood we shall be able to understand, in a mechanical sense, how moving a magnet disturbs every other magnet wherever it may be; why chemical compounds are possible; why crystals assume geometrical forms; and why cellular structure in plants and animals can embody what we call life."

ZOOLOGICAL.

By R. LYDEKKER.

The Pen-Tailed Tree-Shrew.

BORNEO has hitherto been supposed to be the sole habitat of a very remarkable little animal known as the pen-tailed tree-shrew (*Ptilocercus lowii*). The creature is a near ally of the tupais, or tree-shrews, of the Indo-Malayan region, but is very small, and has an exceedingly long cylindrical tail, which, instead of having a fringe of long hairs on opposite sides throughout its length, is furnished merely with a vane of such hairs near the tip. Recently a specimen has been taken in the Selangor district of the Malay Peninsula. Since the long-nosed crocodile known as Schlegel's gharial (*Tomistoma schlegeli*), which was also long supposed to be confined to Borneo, has likewise been discovered in the Malay Peninsula, it is evident that the fauna of these two areas has more in common than was formerly supposed.

A Giant Pig.

From the later Tertiary deposits of Nebraska has been recently described the fossilized remains of a gigantic fossil pig, which has been named *Dinochoerus hollandi*, in honour of the Director of the Carnegie Museum, who recently brought the *Diplodocus* skeleton to the British Museum. Some idea of the enormous size of this monster will be gathered from the fact that its skull alone measures nearly a yard in length.

The "Siruku."

The Mandingos of Liberia, according to Sir H. H. Johnston, "talk a great deal about a striped animal which they call siruku. They recognised a picture of a zebra, and called it siruku, but at the same time described the animal as being extremely ferocious and dangerous to life. As it is impossible to recognise this description as applying to the zebra, I thought from their gestures that they might mean the leopard; but to the leopard they gave a totally different name—soli. Moreover, they were particular that this animal had stripes. It may be the striped hyæna. At the same time, on every occasion when they were shown the pictures of a zebra they declared that this was the creature they called siruku, but that in their country it was ferocious." Even if the siruku be the striped hyæna, it will indicate an animal possibly a distinct race or species new to the West African fauna. In India, at any rate, striped hyænas are skulking cowardly brutes, which never voluntarily attack man; but this scarcely accords with the character given to the mysterious Liberian animal.

A Gorilla at the "Zoo."

The menagerie in the Regent's Park has received a fine female gorilla, imported from French Congo-land, in company with no less than seventeen young chimpanzees. On arrival at the docks, the gorilla was reported to be in fair health, although suffering from its somewhat restricted quarters on board ship, and since its transference to the Regent's Park has apparently done well. It is the largest specimen imported of late years.

Bubble-Nesting Fishes.

Most, if not all, of the fishes allied to the celebrated "climbing-perch" (*Anabas scandens*) have the remarkable habit of constructing "nests" or floats of bubbles, in which their eggs are placed during the period of development. All these fishes are brilliantly coloured, and, with the exception of one African species, are natives of the Indo-Malayan rivers. Among those definitely known to make floats of this nature are the gourami (*Osphromenus olfax*), renowned for the excellence of its flesh, the paradise fish (*Polyacanthus opercularis*), and the fighting fish (*Betta pugnax*), so called on account of a domesticated breed being kept for fighting by the Siamese. Specimens of the two latter have recently been kept in aquariums by an English naturalist, where they have constructed their bubble rafts, which are more or less dome-like in shape. In the case of the paradise fish, the layers of bubbles, which are blown by the male fish, are gradually increased, and to such an extent that the eggs are raised above the level of the water, in which position they are hatched.

REVIEWS OF BOOKS.

Spectroscopy. E. C. C. Baly, F.I.C. (Longmans; 10s. 6d.).—There is probably no subject for which a new English text-book was more required than that of spectroscopy. The advances made have been so considerable that a mere revision of any existing textbook would have been totally insufficient. In Germany a thoroughly satisfactory encyclopædic handbook is being brought out by Professor Kayser, and this will probably serve as the ultimate book of reference for some time to come. But this is too elaborate a treatise for the ordinary student, even when the language in which it is written does not prove an obstacle. The reproach that there is no adequate English textbook is removed by the present publication, which forms one of the textbooks of physical science edited by Sir William Ramsay, who is to be congratulated on having placed the subject in the hands of one so competent to treat it with distinction. The characteristic feature in the treatment is the fulness in the descriptions of experimental detail, and of the conditions upon which success in spectroscopic measurements depends. The prismatic and diffraction spectra, and the much derided but now victorious interference methods for the determination of wave-lengths are successively described in great detail. It is a pity that the present edition was not in time to make use of Schuster's recent important demonstration of the erroneousness of much that has been written and accepted as gospel on the purity of spectra. The survival of this error vitiates part of what has been written in Chapter X. The student may here be warned that Schuster's original expression for the purity (p. 317) must be accepted in place of the more elaborate (but erroneous) formula of Wadsworth's; and consequently he should alter the formulæ in this chapter accordingly.

Sixty pages are devoted to the means of producing the luminous sources of spectra; and twenty-four to the various kinds producible. Chapter XV. consists of an elaborate and very complete account of the series of lines in spectra and the different formulæ which have been devised to represent them. We miss, though, any reference to Nagaoka's theoretic discussion of the reason of the existence of these series. There is a wide field here in which much has yet to be done; and the full and clear account which Mr. Baly gives will be a very welcome summary of experimental facts to those who are interested in the matter. An outline of present experimental knowledge of the Zeeman effect forms Chapter XIV. It must be understood that the treatment throughout is limited to simple mathematics. It is, of course, impossible to put everything under one roof; and copious references to original sources guide the reader who wishes for fuller information. There are very few inaccuracies. The first account of the ideal grating was given by Schwerd not by Rayleigh; and Newton *did* use a slit; though it is quite common to find it denied of him. In biaxal crystals *neither* ray is, in general, ordinary; the definition of optic axis on p. 96 is imperfect. The logic on p. 155 in connection with resolving power is of the circular type. These, however, are minor matters; and they do not appreciably detract from the great value of this important work.

Structural and Field Geology, by James Geikie, LL.D., &c., author of "The Great Ice Age," &c. (Edinburgh: Oliver and Boyd. London: Gurney and Jackson. Pp. xx. and 435. Price 12s. 6d. net. With 61 full-page plates, and 142 illustrations in the text).—It is a pleasure to call attention to this excellent manual, in which Dr. Geikie has traversed the whole field of the geological world in a manner which must cause it to be of the utmost value, both to the purely scientific geologist and to those engaged in professions in which a general knowledge of the principles of geology is a necessity. While furnishing excellent reading for the general public interested in the subject, it will undoubtedly be useful as a manual to guide the student in the acquisition of exact and accurate knowledge. It is a work, too, which should be in the hands of all engineers who have in the slightest way work to do in which a knowledge of the constituents of the crust of the earth is necessary. The illustrations are excellent, and in the absence of actual specimens of the minerals and rocks referred to in the text, nothing could be better for purposes of the student. As instances, we may mention the section of an agate, on Plate I.; tabular

granite of Goatfell, on Plate XXXV.; columnar basalt, on Plate XXXVII; and dendritic markings on limestone, on Plate XXVII. Students are carefully shown how geological surveying is performed in Chapter XVIII. and succeeding chapters. Dr. Geikie has produced an excellent work which will, if possible, increase the esteem in which he is held by the geological world.

Elementary Experimental Science. W. M. Heller and E. G. Ingold. (Blackie and Son.) This is a book written essentially for teachers and not for pupils. It represents an endeavour to indicate the spirit of the teaching and the method of instruction to be followed in order that the maximum educational efficiency may be obtained from the subject. With the exception of one object lesson on feathers, all the lessons are on physics and chemistry. It would be easy to select other experiments, and any specially intelligent teacher would no doubt do so; but to the more ordinary man who can value the advantage of assistance in this respect the book must be very highly commended. When the British Association met at Belfast, the writer of this notice had the pleasure of being conducted through an exhibition of pupils' work which had been done on the same lines as those described here. The conductor was himself a pupil; and it is unquestionable that in one lad, at any rate, the methods had succeeded in creating a lively interest in experimentation. There was, indeed, one fact which he spontaneously stated that he could not understand; viz., why a small body of water in the narrower limb of a U-tube can balance the larger body in the other limb. We have, therefore, looked up this particular point in the book before us, and we find that the treatment of the subject of fluid pressure is not very clear. The method throughout is the heuristic one—a phrase which as defined in the introduction refers to "carefully directed inquiry." But how can it be inferred from experiment 96 that the earth is subjected to an atmospheric pressure *in every direction* of about 15 lbs. per square inch. The fact implied by the three words which we have put in italics cannot be deduced from the experiment itself; nor can it be from any other of the experiments described. When we have made these criticisms there is none of an adverse nature to make. We cordially recommend the book to every school teacher or to any one who is concerned with the creation of scientific habits of thought in children.

Bird Life Glimpses, by Edmund Selous (London: George Allen, 1905).—This book contains a great deal of "twaddle," and not a little that is akin to nastiness—most decidedly it is not a book that we should care to put into the hands of the young. Detailed descriptions of the act of coition as practiced among birds are not, surely, subjects which should be discussed in a book which has all the outward semblance of a volume designed for the children's library, or the drawing-room. Apart from this, its pages contain a great deal of padding that could well be dispensed with. Such, for example, as the discussions on Art and Psychology, which are irritating. The author here and there condescends to say a kind word for scientific men, and now and then, apparently lest they should become puffed up by such notice, he pokes fun at them—fun of a sort! Occasionally he indulges in a little hypothesis hatching—we venture to think the resulting chicks are destined to fill an early grave. We are sorry not to be able to speak more favourably of the book, for, like the curate's egg, it is good in parts, and the author writes in a pleasing style, except that he will bespatter his pages with phrases in French, German, and Latin. He makes even the poor birds talk in German! The most pleasing feature of the volume is its illustrations, which are delightful—as pictures by Mr. Lodge always are. W.P.P.

Poisonous Plants of all Countries, by A. Bernhard Smith (Bristol: John Wright and Co. London: Simpkin, Marshall. Pp. 88).—This little book consists of tables of various plants arranged according to their action on the brain, spinal cord, heart, together with lists of vegetable irritants. In each case the toxic principle or principles are given. It would, perhaps, have been interesting to the general student if remedies had also been given. As a compilation, the work has apparently been done well. There are two coloured plates illustrating the fungi.

The New Science of Causation, by H. Croft Hiller (Walter Scott Publishing Co.; 10s. net).—Consisting of "Easy Duologues, laying bare the hitherto hidden, and ensuring a general collapse of the foundations of Materialistic Science." This is but a collection of childish arguments strung together and couched in grandiloquent phraseology, and if it be said that it contains some few suggestions worth thinking over, that is all that can be said in favour of this pretentious work.

Pannell's Reference Book (The Granville Press; price 6s. 6d. net).—This volume contains a really marvellous amount of information, and is quite the most complete reference book we know of. The price too is extraordinarily low for a volume of nearly 1000 pages. Large cyclopædias are all very well for those who have the time to study them, but for purposes of reference, to ascertain some fact such as one continually wants to know, this work seems to be amply sufficient. There is just a question as to whether the arrangement is perfect. One will have to learn one's way about the book before the desired information can be readily got at. It may often be a difficulty to know whether to refer to the Dictionary, the Dictionary of General Information, or to the Medical, Legal, Social, or Commercial Guide to ascertain some particular fact. Cross references might be given more freely. For instance, if you look up "Bridges" in the General Information Section, many facts are recorded, but no reference is made to p. 420, where may be found many details of "Notable Bridges." The information given seems to be, on the whole, very correct, though one might naturally expect, in so comprehensive a collection, a few inaccuracies or omissions. Scientific facts are concisely given, if sometimes a little too vague. For instance, under the heading of "Stars" it is stated, with reference to the grouping in constellations, "of these, twelve are visible in both the northern and southern hemispheres, and are known as the Zodiacal constellations;" and again "In the Southern hemisphere the chief constellations are Orion and the Southern Cross." Such statements, though slightly misleading, cannot be said to be incorrect. There is so much within these covers; what with "Hints to Authors," "Guide to Professions," "Heraldry," "Elections," "Customs Tariffs," "Social Duties and Aids to Culture," Statistics, &c., that it is impossible to mention all in detail. On the whole this book is to be thoroughly commended, and should prove so useful and so desirable as an educator that we should like to see it in every home and in every office throughout the empire.

"The Zoologist," for June, July, and August.—Among the more important articles may be mentioned one by Mr. J. G. Millais in the June number, on the affinities of the black rat (*Mus rattus*) and its relatives, in the course of which a race new to the British Islands is described and figured. In the July number is published the interesting address on bird migration read before the recent Ornithological Congress by Dr. O. Hermann, and an article on terns in Norfolk by Mr. A. H. Patterson. Extermination in animal life forms the title of an article in the July issue (to be followed by others) from the pen of the editor, Mr. W. L. Distant, in which some remarkable errors in connection with distribution are noticeable.

The Museums Journal, Vol. IV., July, 1904, to June, 1905, pp. x. + 245, illustrated (London: Dulau and Co., 1905; price, 12s. net).—According to the report read before the Norwich Conference in the summer of 1904, the Museums Association continues to make steady progress, its roll of members augmenting, its finances increasing, and its annual volume increasing in size. Its usefulness to those connected with museums seems also to be more and more appreciated year by year; while it is extremely satisfactory to learn that a certain number of delegates now attend its annual conferences. A very useful feature of the *Journal* is the list of museums in Great Britain and Ireland, of which a portion appears in the volume before us. Much of the success of the Association and its journal is due to the untiring efforts of the Secretary and Editor, Mr. E. Howarth, of Sheffield.

We have received from Messrs. S. Rentell and Co. their catalogue of books on electricity, which includes works on all branches of the subject, varying from 6d. to 63s.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Limit of Visibility of Isolated Elements in the Microscope.

K. Strehl has made some interesting observations in connection with the recent work of Siedentopf and Zsigmondy, whose speculations as to the visibility of ultra-microscopic particles he regards as partly hypothetical, partly not free from other objections, and considers their actual results as of most importance. With the most intense sunlight with an illuminating system of N.A. 0.3, and an observation system of N.A. 1.2, used with strong oculars, the least value they obtained for the edge of their cube-shaped gold particles was 4 $\mu\mu$. (= .000004 m.m.) for bright spots on a dark ground. For dark spots on a bright ground, on the basis of the diffraction theory, with N.A. 1.5., wave-length 500 $\mu\mu$. eye-sensitiveness limit 5 p.c., and a completely aberration free pencil, Herr Strehl himself has demonstrated the following limits of visibility:—Smallest diameter of round dark apertures, self-luminous 48 $\mu\mu$., illuminated 54.5 $\mu\mu$., and smallest breadth of straight dark slits, self-luminous 10.5 $\mu\mu$, illuminated 2.5 $\mu\mu$. The comparison of both methods of observation, as well as the results, has importance in connection with the investigation after ultra-microscopic bacteria. Compare the original statement in Central Zeit. f. Optik. u. Mech. xxvi. (1905), p. 117, and J.R.M.S. (1905), p. 521.

Imbedding with Incomplete Dehydration.

W. J. V. Osterhout, Univ. California, Pub. Bot., and J.R.M.S. (1905), p. 526, recommends the use of a saponaceous medium for imbedding vegetable tissues instead of paraffin, namely, cocoanut oil and sodium hydrate mixed in the proportion of 70 c. cm. of oil to 58.5 c. cm. of 28 per cent. solution of KHO in water. The oil is warmed in a water-bath, and the lye added gradually, the mass being stirred meanwhile. The tissue to be imbedded is warmed in a water-bath, and the soap added as long as it will dissolve. The whole is poured into a suitable receptacle until sufficiently firm to cut into blocks. The blocks are then treated as in the paraffin method. Perfect sections, one micron thick and several feet long, are easily obtained. The sections may be treated in the usual way, either by making them adhere at once to slides, or by first dissolving out the soap by soaking them in water. If required to be fixed to slides in serial order, they are placed on slides previously coated with white of egg and then dried; they are then moistened with xylene, which spreads them out, and makes them adhere. A piece of absorbent muslin is next pressed gently on the sections, and when the xylene has evaporated, the muslin is moistened with water. The slide is then heated to coagulate the albumen, and fix the sections to the slide. The muslin is now moistened again, and afterwards carefully removed, after which the sections can be treated as usual. Alcohol may be used instead of water for imbedding by this method. The tissue partly dehydrated is placed in alcohol on a water-bath, and soap added till no more will dissolve.

Microscopical Lectures.

The Manchester Microscopical Society have again sent me their annual prospectus of lectures for the coming winter, which are given by members of the Society, for the most part gratuitously, save for out-of-pocket expenses, in the districts around Manchester, and even in the North-West Riding of Yorkshire and the Western Counties. The list of lectures numbers 55, and of lecturers 19, and the lectures are given at meetings of any society, science club, mechanics' institute, etc., which applies for them. Practical demonstrations in microscopy, microscopical exhibitions, and the mounting of microscopic objects are also given if required. So excellent a scheme deserves the highest commendation, and might, with advantage, be imitated by other societies. In particular, it seems to me that the Quekett Club could well extend its usefulness by adopting such a scheme as this. It would bring microscopical matters before a larger public, would disseminate scientific knowledge, could not fail to increase the numbers of those who are interested in microscopical matters, and, incidentally, would make known the work of the club, and bring it new members. What the Manchester Microscopical Society can do in the populous districts in and around Manchester could surely not fail to be even more successful in the densely populated district of London.

Glycerine as a Mounting Medium.

The use of glycerine as a mounting medium, convenient as it is in many respects, has several disadvantages. Pure glycerine has a refractive index of 1.46, but, by diluting it with an equal quantity of water, the refractive index is lowered to 1.4, and thus the visibility of many structures is increased. It is important, however, that the object should be thoroughly impregnated with glycerine, and a fruitful cause of difficulty is the presence of air bubbles in the tissues; such air bubbles, unlike those in objects mounted in Canada balsam, not being subsequently absorbed. The essential difference between mounting in Canada balsam and mounting in glycerine is that, whereas objects mounted in the former medium must be thoroughly dehydrated—that is, freed from every trace of water—objects mounted in the latter medium must be mounted direct from water only. It is advisable, therefore, to soak the object carefully in water, and to use water that has been recently boiled, to get rid of any air in it. After this, the object must be well soaked in glycerine until every part of it is thoroughly impregnated. Glycerine jelly contains gelatine, and requires to be melted before use, after which it sets again; Farrant's medium contains gum arabic, and sets at the edges; but glycerine itself not only does not set, but is so hygroscopic as to absorb water readily from the air. The mounts must, therefore, be enclosed in some way—ringed, as it is termed. The usual way is to centre the slide on a turntable, and ring the cover-glass with a thin circle of melted glycerine jelly, and, after this has set, to ring again with one or two coats of gold size. The gold size must not be too thin; in fact, it should just be thin enough to leave the brush easily, and no more. Any other cement, such as zinc white or Brunswick black, may then be applied on the top of the gold size. Another, and less-known method, is to ring in the same way with Canada balsam instead of glycerine jelly. The balsam, likewise, should be comparatively thick. It is important, however, that both cover-glass and slide, beyond the border of the former, should be quite

free from glycerine, otherwise the balsam will not adhere, and it needs some little practice to know the exact amount of glycerine to use in mounting so that it will just reach to the edges of the cover-glass and no more. Glycerine is able to find its way, sooner or later, through most cements, but slides that I have ringed in this way with Canada balsam some years ago are still quite firm and sound.

Watson's New Model Microscope.

The Continental type of microscope has obtained so firm a hold in our science laboratories that many teachers and students will not look at any other instrument than one possessing the familiar horse-shoe foot, and upright bar carrying the limb and body-tube. This is not the place in which to discuss the respective merits of the English and the Continental microscope; this preference exists, and instrument makers have to reckon with it. In certain cases they have done so, by surrendering at discretion to the wishes of their customers and, whilst admitting that the step is in many ways a retrograde one, giving what is asked for by supplying a microscope made exactly on the Continental model. Messrs. W. Watson and Sons have attacked the problem in an entirely new and characteristically original way. They have just brought out a new microscope, which apparently follows the Continental model closely, but which never-the-less differs from it vitally. It has the horse-shoe foot, foot and pillar being cast in one solid piece, but instead of the upright triangular bar above mentioned, actuated by a direct-acting micrometer screw, and bearing the whole weight of limb and body-tube, the stage and limb are also cast in one solid piece, and Watson's well-known lever fine adjustment is retained, with all its advantages, though the shape of the limb and the appearance of the milled head are those of the Continental microscope. In other words Messrs. Watson retain the essential advantages of the English lever fine adjustment, and conform outwardly to the too familiar Continental appearance. In all other respects the microscope follows Messrs. Watson's usual type, of which the well-known "Edinburgh Student's" and "Fram" Microscopes may be taken as examples. The new microscope is christened the "Praxis," and an elaborated form is to be known as the "Bactil." Concerning certain fittings of this instrument, I shall hope to be able to say something next month. The new microscope appears to me to be a most ingenious method of meeting prejudice without yielding on the really important principles of design. The names, however, which Messrs. Watson choose for their various instruments seem more open to criticism.

Distribution of Wood Pulp.

With reference to my recent article in this journal on "Fibrous Constituents of Paper," by the kindness of Mr. J. Strachan, of Ballyclare, I am able to offer, to any of my readers who care to send me a stamped addressed envelope, some samples of chemical and mechanical wood pulps, such as are used in paper-making. To these I can myself add a sample of a pure esparto paper, and a sample of a brown paper containing hemp, manila hemp, jute, and linen.

Notes and Queries.

F. Oppenheimer (Chorlton-cum-Hardy).—I see no impracticability in your design for a fine adjustment to the sub-stage of your microscope which can be actuated without moving the hand from the fine adjustment of the body tube, but I am afraid you will find it costly to make, and I question if the advantage gained would be commensurate with the expense. The sub-stage does not require frequent adjustment when one is examining a slide—once adjusted for any particular slide it is practically in focus whilst the whole object is being examined. I may perhaps say that I myself use the fine adjustment to the sub-stage a good deal, and I have never found the existing arrangement in any way inconvenient. If, however, you propose to proceed further with the matter, I will make one or two suggestions. The first is that the arc with diagonal rack actuating the fine adjustment would be difficult to fit accurately, and it would be simpler and equally effective were you to have the lever pressed upon and so moved by the end of the screw attachment of the milled head, space being left for the milled head to travel vertically. Or you could fit a moveable collar to this screw which could be kept from rotating either by a pin or by a square fitting. The second suggestion is that the screw part of the micrometer screw to the sub-stage is quite unnecessarily long and elaborate in its mounting.

A. J. Attridge (Cape Town, S. A.).—I think the photo-micrographs you send me are very good for early attempts, and the mounting also is good, especially the Flea. The others, except the blow-fly proboscis, might with advantage be a little more transparent. The illumination is equal, but the details are somewhat insufficiently shown. For instance, in the blow-fly proboscis the details of the suctorial tubes should be more evident even with this low magnification and the fine hairs on the membrane of the proboscis—those in the centre space for instance, should be evident. I mention these matters because it is only by attention to little details of this sort that one realizes the advantage of a really "critical" image and rigid focussing. It is important to bear in mind that such details are not best brought out by stopping down the iris diaphragm of the condenser. This may at first glance appear to increase the contrast, but in reality the whole image is blurred and coarsened, the finer details are lost, and they may even be surrounded by a sort of halo due to diffraction, whilst the resulting print shows all such errors even more clearly than they are seen visually. I would suggest also that silver prints are less satisfactory for photo-micrographic work than bromide papers, which give very sharp blacks and whites.

F. R. M. S. (Sheffield).—I think, perhaps, the best all-round text-book on botany is Strasburger's, translated by H. C. Porter, and published by Macmillan and Co. at 18s. net. It is very good for morphology and physiology, but the descriptive botany is scarcely full enough for use as a work of reference. Without being too elementary it is also not too advanced. For more advanced work you might read Sachs or Goebel, and De Bary's "Comparative Anatomy of the Phanerogams and Ferns," all published by the Clarendon Press. For the naming of indigenous plants the easiest book to use is Bentham and Hooker, published by L. Reeve and Co. at 10s. 6d., with a supplementary volume of illustrations at the same price, but the classification is out of date, and now looked upon as unsatisfactory. There can be no more delightful book to read than Kerner's "Natural History of Plants," published with profuse illustrations by Blackie and Co. in two thick volumes—it is more like an interesting story than a book on botany. An excellent book of its kind is Willis's "Manual of the Flowering Plants and Ferns," published by the Cambridge University Press at 10s. 6d. For practical work I think Strasburger's "Handbook of Practical Botany" is the most helpful to the private student. It is published by Swan, Sonnenschein and Co. at, I think, 8s. 6d., and contains very full and detailed descriptions as to methods. Bower's "Practical Instruction in Botany" is a well-known book. A very useful little book is Chamberlain's "Methods in Plant Histology," published by the University of Chicago Press, and which, I think, can be got through Chapman and Hall, of London, at about 4s. I hope from among these you will be able to obtain what you want.

W. D. Dade, A. H. Glaisher, and Others.—I am sorry that, owing to its being vacation time, and to my having only just returned from abroad, I am unable to answer your questions this month, but I will try to do so next month.

[*Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for October.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.1 and sets at [illegible]; on the 31st he rises at 6.53, and sets at 4.35.

Sunspots are numerous, and recent spectroscopic observations of the Sun's limb have shown many active prominences.

The position of the Sun's axis and equator, required for physical observations of the Sun, is indicated in the following table:—

Date.	Axis inclined from N point.	Equator S. of Centre of disc
Oct. 1 ..	2[illegible] 10′ E	6° 37′
.. 11 ..	2[illegible] 28′ E	6° 2′
.. [illegible] ..	2[illegible] 3′ E	5° 15′
.. [illegible] ..	24 5[illegible] E	4 18′

THE MOON:—

Date.	Phases	H. M.
Oct. 5 ..	☽ First Quarter	0 54 p.m.
.. 13 ..	○ Full Moon	11 3 a.m.
.. 21 ..	☾ Last Quarter	0 51 p.m.
.. 2[illegible] ..	● New Moon	6 58 a.m.
.. 14 ..	Apogee 252,600 miles	0 30 p.m.
.. 2[illegible] ..	Perigee 221,800 ..	4 30 a.m.

THE PLANETS.—Mercury is a morning star during the early part of the month, but the planet is not suitably placed for observation, as he is in superior conjunction with the Sun on the 12th.

Venus is a morning star in Leo and Virgo, and throughout the month rises about 3 hours in advance of the Sun. On the morning of the 8th the planet will be in conjunction with the star χ Leonis, passing about 10′ to the south of the star. In consequence of increasing distance from the earth the lustre of the planet is diminishing.

Mars is a feeble object in the S.W. evening sky, setting about [illegible] p.m.

Jupiter is now well placed for observation before midnight and is the most conspicuous object in the sky looking E. about [illegible] p.m., being situated in Taurus about midway between the Pleiades and Aldebaran. The equatorial diameter of the planet on the 16th is 47″·0 whilst the polar diameter is 3″·0 less. The following table gives the satellite phenomena visible in this country, before midnight:—

Date.	Satellite.	Phenomenon.	P.M. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.
Oct.				Oct.				Oct.			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	II	Oc R	8 22
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		I	Sh I	1[illegible] 0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		I	Tr I	1[illegible] 16
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		I.	Ec D.	7 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	I.	Oc R	10 6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	I	Tr E	7 21
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		III	Sh I	7 15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		III	Sh [illegible]	9 2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		III	Tr I	1[illegible] 15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	III	Tr E	11 35
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	II	[illegible] I	11 56
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		II	Ec D	6 5
					[illegible]	[illegible]	[illegible]		[illegible]	[illegible] I	1[illegible] 3
									I	[illegible] I	11 51

[illegible]

Saturn is suitably placed for observation in the early evening, being due south about 8.20 p.m. near the middle of the month. The planet is describing a short retrograde path in Aquarius, but is at the stationary point on the 31st; the moon appears near the planet on the evening of the 8th.

The ring is well open, and we are looking on the northern surface at an angle of 11½°; the polar diameter of the ball is 16″·8, whilst the major and minor axes of the outer ring are 42″ and 8″·4 respectively.

Uranus is situated about 2° south of the star μ Sagittarii, the planet is on the meridian shortly after 4 p.m., and sets about 8.15 p.m. near the middle of the month.

Neptune rises about 9 p.m. on the 15th; and is due south about 5 a.m. The planet is situated in Gemini, is in quadrature with the Sun on the 4th, and at the stationary point on the 14th.

METEORS:—

The principal shower of meteors during the month is the Orionids.

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
Oct. 8-29 (18 to 20 maximum)	92	15° N.	Swift, streaks.

Minima of Algol may be observed on the 1st at 8.52 p.m., 4th at 5.41 p.m., 21st at 10.35 p.m., and 24th at 7.24 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—γ Arietis $1^h\ 48^m$, N. 18° 48′, mags. 4·2, 4·4; separation 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedæ $1^h\ 58^m$, N. 41° 51′, mags. 2·1, 4·9, separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

NEBULÆ:—

Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a 3 or 4 inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2′ to the south. It is fairly round, and appears somewhat like a star out of focus.

(18 H_{V}) lies about the same distance north of the great Andromeda nebula that 32 M does south; it is faint, but large and elliptical.

"Knowledge" on Bookstalls.

COMPLAINTS having reached the office of the difficulty of obtaining "KNOWLEDGE" at certain provincial shops and book-stalls, we beg to say that the paper is always published before the 1st of each month and should be on sale on that date. We cannot, of course, be responsible for such delays, but when copies are ordered direct from the office they are posted so as to be delivered on the 1st of the month. For rates *vide* page vii. Under the new five-year rate, subscribers get their copies post free for 5d.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

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A Possible Celestial Catastrophe.

By J. E. GORE, F.R.A.S.

IN the Second Epistle of St. Peter there is a prediction of the destruction of the world by fire. It is a matter of some uncertainty whether this epistle was really written by the apostle Peter. There are no certain traces of it earlier than the 3rd century. Its authenticity was questioned by Origen, and St. Jerome says that many in his time rejected it. The difference in style between the first and second epistle is so marked that modern critics think it improbable that the second epistle was written by St. Peter. But there is "no consensus of opinion against it," and as it is now universally admitted into the canon of Scripture we may, perhaps, accept it as genuine. However this may be, it seems remarkable that in the great Sanscrit epic poem, the "Mahabharata," there is a distinct prediction of the destruction of the world by fire. In that ancient work, the following passage occurs:* "O King, towards the end of those thousands of years. constituting the four *Yugas*, and when the lives of men become very short, a drought occurs extending for many years. And then, O Lord of the Earth, men and creatures, endued with small strength and vitality, becoming hungry, die by thousands. And then, O Lord of men, seven blazing suns, appearing in the firmament, drink up all the waters of the earth that are in the rivers or seas. And, O bull of the Bharata race, then also everything of the nature of wood and grass that is wet or dry is consumed and reduced to ashes. And then, O Bharata, the fire called *Samvartaka*, impelled by the winds, appeareth on the earth that hath already been dried to cinders by the seven suns. And then that fire, penetrating through the earth, and making its appearance in the nether regions also, begetteth great terror in the hearts of the gods, the *Danavas* and the *Yakshas*. And, O Lord of the Earth, consuming the nether regions, as also everything upon this earth, that fire destroyeth all things in a moment," etc. This agrees with St. Peter's words, "The elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up." The idea of "seven suns" in the above extract is also in curious agreement with the words of the prophet Isaiah (chap. 30, v. 26), "Moreover, the light of the moon shall be as the light of the sun, and the light of the sun shall be sevenfold as the light of seven days in the day that the Lord bindeth up the breach of his people, and healeth the stroke of their wound." Assuming the truth of these remarkable predictions, let us see how the catastrophe of a general conflagration might be brought about by the operation of natural causes without the intervention of a miracle.

Some have supposed that such a catastrophe might possibly be produced by an outburst of the internal fires of the earth. But such an hypothesis—in itself very improbable in a cooling globe like the earth—is directly opposed to St. Peter's words. He says: "The heavens,* being on fire, shall be dissolved," clearly indicating, I think, that the fire is to come from the *outside*; "the heavens," not the earth, being on fire, is to be the immediate cause of the catastrophe. Others have thought that an outburst in the sun would, perhaps, produce the conflagration, and this certainly seems much more probable. Were the sun to suddenly blaze up, like the "temporary stars," recorded in the annals of astronomy, and of which we had such a brilliant example in February, 1901, in Perseus, then, of course, the earth would certainly be burnt up, and at least everything on its surface would at once be reduced to ashes. But, although this is, of course, within the bounds of possibility, such a catastrophe is not, I think, at all probable. There are, to be sure, small outbursts daily taking place in our central luminary, as indicated by the "prominences," or red flames, visible

* From an English translation of the *Vana Parva*, by Pratap Chandra Ray, C.I.E. Second Edition, 1889, p. 561

* Here the word "heavens" means the earth's atmosphere.

round the sun's limb during total eclipses; but these are of comparatively small importance, and not likely at any time to endanger the earth's safety. An outburst on a much larger scale would be necessary to produce anything in the way of a catastrophe which would destroy all life on our terrestrial abode.

Now is there any cause which would produce a great outburst of light and heat in the sun? I think we have such a cause in the possible collision of the sun with a dark body in space. The distance of the stars is so great, that the collision of the sun with a *star* is a contingency which may be at once dismissed. Such an event, if it ever took place, could not possibly happen for thousands of years to come. To pass over the distance which separates the sun from even the *nearest* fixed star would take, at the rate of, say, 10 miles a second, about 80,000 years!

The existence of dark bodies in space has been suspected by astronomers. I say suspected, for really we have no *direct* evidence that such bodies exist. The idea seems to have originated in the so-called "dark companion" of the variable star Algol. But we have no evidence whatever that Algol's companion is really a "dark body," that is, a body devoid of all inherent light of its own, like the earth. It is true that in the case of Algol the spectroscope shows no sign of a second spectrum, as in some variables of the Algol type in which both components are of nearly equal brightness. But it has been recently found by Professor Hartmann that "a difference of only about one magnitude would be sufficient to bring the spectrum of the fainter component to almost complete disappearance, and a difference of two magnitudes would make it impossible for even a trace of the fainter spectrum to be visible on the plate."* The companion of Algol might, therefore, be of the $4\frac{1}{2}$ or 5th magnitude, and neither telescope nor spectroscope would show any sign of its existence. But, apart from the above considerations, it seems very probable that many dark bodies do exist in space. In the case of large bodies of this kind, they would have their origin in cooled down suns. Stars cannot go on shining for ever. They commence their course with a limited amount of potential energy, and this energy is being incessantly dissipated in the form of radiant light and heat. This dissipation of energy cannot clearly go on continually, and in the course of ages must become exhausted. It is like a man living on his capital. If he receives no interest on it, and goes on spending the money steadily, the day must come, sooner or later, when the capital will disappear, and the man will be reduced to a state of bankruptcy. So it is with a sun. It can receive no energy from without, and it is constantly wasting its capital of energy in the radiation of heat and light. It is true that this waste may be apparently compensated for a time by the contraction of the sun's mass due to gravity. But this is only the conversion of potential energy into heat, and eventually the process must cease, as after a time—counted, of course, by ages—the sun's density will become so great that the contraction will cease, owing to the overcrowding of the molecules, no further heat will be produced, and the body will begin to cool down. When this cooling process has sufficiently advanced, the sun will lose its light, and "roll through space a cold and dark ball." There is evidence to show that in some of the long-period variable stars, this permanent waning of light has already commenced, and it seems highly probable that, in many cases, the "cold and dark" stage has been actually reached. These dark bodies may, indeed, be very numerous, but we have no means of observing them, as they show no light, and would not be visible, even as faint stars, by the largest telescopes which could ever be constructed.

It is now well known that the sun is moving through space with a considerable velocity, and, of course, carrying with it the earth, and all the planets and satellites of the solar system. Various estimates have been made of the point towards which the sun is moving, but the most recent and accurate calculations seem to point to a spot near the bright star Vega (α Lyræ). In its flight through space it seems quite within the bounds of possibility that the sun may some day come into collision with a dark body. Should such an event occur, the collision would, of course, produce an enormous amount of heat and light, and St. Peter's prediction would at once be fulfilled. "The heavens" would be "on fire," and the whole surface of the earth, and everything on it, would be reduced to cinders in a few minutes. It would be like the destruction of St. Pierre on a colossal scale. The world would end

"In unremorseful folds of rolling fire."*

But such a catastrophe could not occur without our knowing of the coming disaster months, and perhaps years, beforehand. When the approaching dark body came within a certain distance of the sun it would begin to shine by reflected light, like the planets. If a very large body, comparable with the sun itself in size, it would first become visible far beyond the confines of the solar system. For some months, or years, its motion would be very slow, owing to its great distance from the sun. It would probably be first discovered as a telescopic star, not differing in appearance from other stars of the same brightness in its vicinity. It would then, perhaps, shine as a star of about the 9th magnitude, as any much fainter star would probably be overlooked. Doubtless it would at first be mistaken for a "new" or "temporary star," or a variable star at its maximum brightness; but the comparative constancy of its light, and its great parallax, or apparent change of place among the neighbouring stars, would soon reveal its true character, and show that it was really near the earth compared with the distance of the stars. It might, however, be mistaken for a distant comet, but if coming directly towards the sun, its change of place would be small, and its light examined with the spectroscope would show a solar spectrum, indicating that, like the planets, it was shining by reflected sunlight. Further, its distance could be calculated from its parallax, and the result would show that no comet would be visible at such a distance from the sun.

I have made some calculations on the motion of this hypothetical body after it became visible as a star of the 9th magnitude, and, therefore, easily visible in a telescope of three inches aperture. Let us suppose the approaching dark body to have the same mass as the sun and the same density as the earth. Taking the earth's density as four times that of the sun, and the sun's diameter as 866,000 miles, I find that the diameter of the dark body would be about 546,000 miles. Now, taking the diameter of Uranus as 33,000 miles, its stellar magnitude as 5.7, and assuming that the dark

* *Astrophysical Journal*, May, 1904.

* Tennyson, *The Holy Grail*.

body has the same "albedo," or light-reflecting power, as Uranus, I find that the dark body would shine as a star of the 9th magnitude when at a distance from the sun of 8.68 times the distance of Uranus, or about 15,000 millions of miles. Further, assuming that the sun is moving through space at the rate of 11 miles a second (about its probable value), and that the dark body is moving directly towards the sun with the same velocity, we can calculate by the laws of Dynamics the time taken by the two bodies to come together, starting with a distance between them of 15,000 millions of miles. The motion for the first few years would be comparatively slow, and, as I have said, the increase in brightness of the dark body would at first be imperceptible. To reduce the distance to 12,000 millions of miles would, I find, take about 3.4 years. At the end of 6.7 years the distance would be reduced to about 9,000 millions of miles, and in 9.8 years to about 6,000 millions. At this distance the brightness of the dark body would increase to about the 5th magnitude, and it would then be distinctly visible to the naked eye. In about 11.8 years the distance would be reduced to 4,000 millions, and in about 14 years the dark body would reach the orbit of Uranus, or, rather, it would be at the same distance from us as Uranus, for its path would not intersect the orbit of the planet, as I will show presently. It would then shine as a star of about —0.4 magnitude, or a little brighter than Arcturus, and would, of course, attract general attention. After this its distance would rapidly diminish, and its light quickly increase. After about a year from this time it would reach the distance of Jupiter. Its light would then be greatly increased. It would appear as a star of about—6½ magnitude, or about 4 magnitudes brighter than Jupiter at its brightest, and about 2 magnitudes brighter than Venus at her greatest brilliancy. It would then be the brightest object in the heavens, with the exception of the moon, and would be the "observed of all observers." After this its motion would become very rapid, and in about 51 days it would be at about the same distance from the sun that the earth is. From this point my calculations show that the velocity would be very rapid, and if a direct collision took place the sun and dark body would meet in about eight days, the velocity of each body being then over 400 miles a second! The effects of such a collision may be easily imagined. Both bodies would be reduced to the gaseous state within an hour, and a stupendous amount of heat would be produced—heat sufficient not only to destroy the earth, but probably most of the planets of the solar system.

If the dark body approached the sun in a straight line, it could not strike the earth itself or any of the planets, for the direction of the sun's motion in space is inclined to the plane of the earth's orbit at an angle of about 60 degrees. The nearest approach of the dark body to the earth would depend on the time of year at which its collision with the sun took place. If this occurred about the end of December the dark body would not approach the earth nearer than the sun's distance, but if the collision took place about June 21st I find that the body would approach the earth within about 80 millions of miles. In the latter case its attraction on the earth would be greater than that of the sun, and it would probably draw the earth out of its orbit. In either case, when the collision took place, the sun's mass would be suddenly doubled, and, according to Professor Young, the earth's orbit "would immediately become an eccentric ellipse, with its aphelion near the point where the earth was when it occurred."* But of course this alteration in the earth's orbit would not concern humanity after the earth, and all its inhabitants, had been reduced to ashes.

It is, of course, possible that the dark body would not approach the sun directly in a straight line, but along an elongated ellipse. In this case it would miss striking the sun, and there would be no collision. But the earth's motion in its orbit would be much disturbed by the powerful attraction of the dark body, and it is not easy to determine what the exact result would be. If, however, the body were moving in a sufficiently elongated ellipse to pass inside the earth's orbit, it would probably pass close enough to the sun to produce a great disturbance in that body, due to tidal action, and a large amount of extra heat would probably be developed. Should the two bodies merely graze each other, an enormous amount of heat would certainly be produced, quite sufficient to cause the earth's destruction.

The approach of the dark body to the sun would form a magnificent celestial spectacle. When it arrived within the sun's distance from the earth it would, I find, shine with about the same brightness as the moon when full, but with a smaller diameter, and it would rapidly increase in brightness of surface as it approached the sun. It would then—especially if the approach occurred in the month of June—begin to show phases like the moon, and we should have the curious spectacle of two moons in the sky, one somewhat smaller than the other!

Instead of a dark body of the mass of the sun, we may suppose one very much smaller, say of the size of Jupiter. In this case, the masses being so unequal, the sun's motion would be much smaller. On the other hand, the dark body would not become visible until it was much nearer to the earth. In the case of a body like Jupiter, say 87,000 miles in diameter, I find that it would become visible as a star of the 9th magnitude at a distance of about 3½ times the distance of Uranus from the sun, or about 6,000 millions of miles from the earth. If the diameter of the dark body was the same as that of the earth, it would shine as a star of the 9th magnitude at about the distance of Uranus, and in this case it would fall into the sun in about three years. The amount of heat produced by the collision would, of course, be very much smaller than in the cases just considered, but it seems very probable that even a body the size of the earth, moving with such a high velocity, when it struck the sun would produce the most disastrous results to the earth. Such a body may possibly be now approaching us. If only the size of the earth, it might easily escape detection until well within the orbit of Uranus, and we might then have only a few months' warning before the final catastrophe occurred.

But, it may be asked, is there any star visible at present which might be identical with an approaching dark body? Well, all I can say is, that I have carefully examined the region round Vega with a powerful binocular field glass, and that at present (April, 1905) there is no star brighter than the 7th magnitude within five degrees of Vega, which is not perfectly well known to astronomers. A careful examination with a 3-in. telescope, or, better still, a photograph of the region would be necessary before a decided opinion could be formed on the subject.

* *Manual of Astronomy*, p 294.

Influenza and the Weather.

By Arthur H. Bell

Scapegoats are always in fashion, for at all times people have shown a strong tendency to put the blame for the ills to which humanity is heir on something or somebody. The bills of mortality, for instance, as soon as ever winter comes grow enormously long, and in looking round for an explanation of this unusual increase it seems the most natural thing in the world to set down the ills of the community to the account of the weather. Influenza, especially, is thus ascribed to the vagaries and pranks of the British climate, but an examination of the facts gives but little support to this popular belief, and it may, indeed, be shown that the scapegoat on this occasion is burdened with misdeeds from which it should properly be free.

The particular variety of the British climate summed up under the heading East Wind has, for example, more particularly been objurgated and anathematised as a breeder of the influenza; but since meteorologists have been studying the anatomy and character, so to speak, of this much maligned wind they have come to the conclusion that the advantages derived by its beneficent action on the land are to be counted as a set-off against its undoubted untoward effects on man and beast. The East Wind, among other good deeds, extracts all the moisture from those land surfaces over which it blows, and so breaks up the soil and puts it in better condition for the sowing of seed, and in this way large tracts of country are, from an agricultural point of view, improved and brought into good condition. This wind it is that breaks up the soil and pulverises it, this beneficent action being recognized by the old proverb that says, "A peck of March is worth a King's ransom."

In passing it may be said that the East Wind, which, like the Gulf Stream, may almost be called a national institution, is, however, mainly to blame for chapped hands and reddened and roughened cheeks so much in evidence when this wind is streaming through the air. That it has these effects on the human cuticle is due to the fact of its being a dry wind. All the moisture, indeed, is taken from it as it journeys across the frozen plains of northern Europe, so that notwithstanding its subsequent journey across the North Sea it is still very dry by the time it reaches the British Isles. As a result it licks up water wherever it is to be found, and, as already mentioned, it is from the land that it takes much of the moisture wherewith it quenches the thirst induced by its long journey. But like so many other surfaces the skin of human beings is constantly giving off moisture, and as the thirsty wind comes along it promptly avails itself of these stores wherever it finds a hand or a cheek exposed to it.

Moreover, it is well known that according as there is little or much vapour in the air, so is the passage through the atmosphere of the heat from the sun assisted or retarded. Bearing this elementary fact in mind it will be understood that since the air is very dry when the East Wind is blowing, the sun's rays readily pass through the air, and hence arises the redness imparted to hands and faces on cold and frosty mornings. Those who have been on the snow on the top of high mountains will readily call to mind the way in which their skin was reddened by the sunshine as it came uninterruptedly through the cold air. The whole of the blame, therefore, for red noses, chilblains, and chapped hands is not rightly to be given to the East Wind, for the sun also bears much of the responsibility. But the influenza in the popular mind is so intimately associated with chapped hands that it seems a ready way out of the difficulty to say that the East Wind is to blame for both. This aspersion on its character has, however, never been proved, and until a stronger case is made out the East Wind ought not to be used as a scapegoat.

As a matter of fact, climatic conditions appear to have only a secondary effect upon visitations of the influenza epidemic. It seems, indeed, to visit the regions round the Poles as impartially as it does those at the Equator, and the Hottentot and the Esquimaux may, as it were, be said to sneeze in unison. Sunshine would seem to have as little to do with its comings and goings as does the dampness or dryness of the air. The records from the rain-gauge and the hygrometer have, from this point of view, been compared with the statistics of the influenza scourge, and when this is done no agreement is found between them. Meteorologists, moreover, now know that different types of weather are associated with two forms of distribution of atmospheric pressure, one of these forms being called cyclonic and the other anticyclonic. With the cyclones the winds are circling strongly upwards and the weather is stormy, rainy, and altogether unpleasant. In the anticyclones, on the other hand, the winds are circling downwards from the empyrean, and they bring halcyon days and bright, exhilarating, cheerful weather.

Now there was once a theory which informed a suffering humanity that their sneezes and wheezes were due to the fact that the influenza germs were generated by hundreds of dead Chinamen drowned in one of those disastrous floods which so frequently occur when the mighty rivers in the celestial empire overflow their banks. The meteorological data, however, proved very conclusively that the wind over these areas blows very regularly in quite the contrary direction necessary to carry the influenza germs to Europe; and those who wished to throw blame on the wind and the weather had accordingly to cast around for another theory.

The new statement of the case asserted that the influenza was provoked by the dust thrown out by volcanoes, and in one particular year it was confidently ascribed to the tremendous volcanic eruption which occurred at Krakatoa in the Straits of Sunda. During this memorable leaping forth of the subterranean fires the quantity of dust thrown into the air was undoubtedly very great. Moreover, all those beautiful sunsets, after-glows, lunar and solar coronae, and haloes seen in abundance at this period were allowably to be attributed to this great cataclysm, and since, moreover, influenza was very prevalent just at that time, nothing was easier than to assign its presence to this volcanic outburst in South-East Asia. At this time also, as shown by the meteorological charts, anticyclonic conditions prevailed over the British Islands,

and since, as already mentioned, the breeze would then be descending from above, the theorists maintained that everything was favourable for the conveyance of the hypothetical germs to the bronchial apparatus of a susceptible humanity. But this method of inducing influenza is something similar to the process of burning down a house in order to procure roast pig. Influenza germs may, unfortunately, be sown without such a display of molecular energy as occurred at Krakatoa, and volcanoes therefore played the part of scapegoat during but a short time. Pumice stone as a suggested source of influenza has, notwithstanding the recent volcanic purturbations, therefore, been abandoned.

Now the great objection to all these theories which demonstrate how the influenza is wafted about by the breezes is found in the fact that people in isolated positions escape the scourge. For instance, lighthouse-keepers, the inhabitants of certain islands, and people on board ships that do not touch land during lengthened periods are not attacked, which they would hardly fail to be were the influenza floating about in the air promiscuously. Prisoners are, as a body, remarkably free from visitations of the epidemic, and serve as a modern instance to disprove the assertion that the weather is at fault. From this point of view it would appear that the best method by which to escape influenza is to break one of the laws of one's country and so secure a moderate period of solitary and isolated confinement.

What seems clear is that the influenza travels from place to place much more quickly than was the case in former years, so that an outbreak say, in Buda Pesth, rapidly journeys to London. As facilities of travel have increased by rail, road, and river, so have the peregrinations of the epidemic been correspondingly accelerated. Investigations indicate very unmistakably that where the stream of travelling humanity is greatest there also is influenza most easily disseminated. It is near the towns that microbes, bacilli, and other objectionable things have their birth, and although the state of the atmosphere may at times be favourable for their transportation, long journeys through the air are fatal to them, for the sun and the wind rob them of their venom. "No climate in the world," said King Charles, "invites a man to walk abroad so many days in the year as the climate of England," and despite the popular impression concerning influenza and the weather, a walk along some country road, or over some wind-filled moor or common is, after all, the surest way to reduce the proportions of the doctor's bill.

As already remarked, different types of weather are associated with anticyclonic or cyclonic conditions, and as regards the latter class of atmospheric vortices, it is possible to trace the track or route they pursue as they journey across the country, the history of their travels being nowadays recorded in the meteorological weather charts. Commonly these storms cross the British Isles in a north-easterly direction, a favourite line of travel being by way of the Caledonian Canal. Now the path taken by the influenza as it passes from town to town bears no sort of relation to the track of the cyclones, which are the chief breeders of damp, cold, windy and rainy weather, and a contemplation of this fact gives no colour to the notion that influenza flies as an arrow by day on the wings of the wind. It is, indeed, not in protecting one's self from the health-giving winds that influenza is to be averted, but rather by a frequent overhauling of the dust-bin, and by taking, as often as possible, a course of sun-baths.

Abnormal Foliage of Sycamore Seedling.

By GRAHAM BOTT, F.L.S.

THE accompanying illustration (Fig. 1) shows a rare abnormal growth of the first pair of foliage leaves of a Sycamore seedling. It will be noticed that complete fusion of the petioles has taken place, and that this fusion has extended to the leaves themselves along the lower two-thirds of their margins, thus forming twin leaves. When compared with a normal seedling (Fig. 2), the anomalous condition is strikingly noticeable; and, since growth proceeds from the angle formed by the leaf-stalks, it is interesting to speculate as to what would have happened in the abnormal form, with reference to further development, had growth been allowed to continue; axillary orientation having been arrested by the union referred to above.

Fig. 1.—A Sycamore Seedling showing twin leaves (natural size).

It is, of course, recognised that several plants exhibit cohesion of the margins of their leaves as a fixed character, and, according to the degree of union, designated by various terms. But it may not be quite so familiar that many leaves of the same plant show interesting transitional conditions from the simple form through variously lobed (connate), up to the completely-divided compound leaf, such as may be found on the Blackberry (*Rubus fruticosus*) and Cinquefoil (*Potentilla reptans*). Partial union is observed readily, also, between the terminal and one of the lateral leaflets of the Ash (*Fraxinus excelsior*). And a similar fusion of the leaflets of the Scarlet Bean (*Phaseolus*) occasionally occurs, thus transforming the compound leaf into a simple one.

However, those instances are considered as reversion to type, and it is strong presumptive evidence of the evolution of the compound leaf from a simple form.

But the peculiar instance of the twin leaves illustrated can scarcely be explained on the above lines, and, although it is often impossible to penetrate Nature's mysterious influences determining changes of form, nevertheless, the following explanation is suggested.

Lack of moisture, followed by excessive supply, causes, on the one hand, an arrest of development, and, on the other, rapid growth. Retarded growth favours fusion, and (in the case of a floral member, at least) a symmetrical condition is brought about by an abundant supply of nutriment. Pressure on the growing point would, probably, play an important part also in causing fusion, owing to the delicate nature of the primary tissue.

Fig. 2.- Normal Sycamore Seedling (two-thirds natural size).

Now, when the circumstances are considered in which the present specimen grew, it is found that all the above conditions were fulfilled. It is, therefore, reasonable to suppose that the above explanation is the correct one.

It will be observed that both cotyledons are present, otherwise the suppression of one might have been a determining factor in producing the irregular seedling. The specimen was found, by the author, growing on a gravel path near a stone wall, on the south side, during a dry spring, followed by a wet summer. Thus the fact of its adverse environment and irregular nourishment resulted in the inability of the young tissue to work out its hereditary inclination, or to follow that mysterious ancestral impression which has determined all forms throughout the countless æons of the past.

What is Scent?

By Dr. J. G. McPherson, F.R.S.E.

A DICTIONARY will say that "scent is that which, issuing from a body, affects the olfactory nerves of animals." But that is not a complete definition. For the issuing source of the scent may be solid or gaseous. Until very recently it was assumed that there were solid particles of the perfuming body to produce the effect.

And certainly that theory has unduly startled thinking people as to the extraordinary divisibility of matter. We are faced by very startling facts; but it is a stretch of the imagination to account for them by the ordinary matter-divisible theory. The tenth part of a grain of musk will continue for years to fill a room with its odour, and at the end of that time will not be appreciably diminished in weight by the finest balance. So acute is the sense of smell in some trained men that one part of prussic acid can be detected in about two million parts of water; and it has no decided smell, only a strange fustiness.

The faculty of scent is very acute in certain insects. If a virgin female of the moth known as *Saturnia Carpini* is shut up in a box, males of the same species will trace her out for a mile through the parti-odoured air of a wood. The infinitesimal emanation from the female is powerful enough to direct the male all that distance. All are familiar with the remarkable scent of the condor for carrion in Eastern countries, but the scent of dogs seems to eclipse all in its marvellous effects.

For ages it was considered certain that the musk and other scents exist in the air after they leave their visible form in solid particles. Now, Dr. John Aitken, F.R.S., has, by experiments, proved that these pass off as a gas or vapour. He has principally employed his well-known cloudy-condensation test. If the musk is in solid particles, these particles will become nuclei of cloudy condensation in super-saturated air, and thus make their presence visible. But this is not the case.

As to cloudy formation in general; ocular demonstration can easily testify to it. If two closed glass receivers be placed beside each other, the one containing ordinary air, and the other filtered air (that is air deprived of its dust, by being driven through cotton-wool), and if jets of steam be successively introduced into these, a strange effect is noticed. In the vessel containing common air, the steam will be seen rising in a dense cloud, but in the vessel containing the filtered air, the steam is not seen at all. Dust-particles are necessary in the air to allow vapour-condensation on the free surfaces, so as to form cloud-particles.

Dr. Aitken has given us a simple method of showing that the solid particles in the air seem to have a lower limit to their size, but that they are never so small as to be capable of diffusing or not being separated but by the action of gravitation. If a glass flask containing common air be provided with an india-rubber stopper, which has two apertures in it, in which are fitted two tubes, one of these tubes is connected with an air pump, and the other with a cotton-wool filter, a stop-cock being introduced in the latter. A little water is put in the flask to moisten the air. If the stop-cock is closed and the pump-handle is pulled out a very short length, cloudy condensation at once takes place, the very smallest expansion being sufficient to

cause the dust nuclei in the air to become centres of condensation, and that is the case even with the very smallest dust-particles.

If part of the cotton-wool be taken out of the filter and only enough be left to keep back all but a few particles, and these of the very smallest size, yet these require but the very slightest expansion to make them visible. If the process of successive expansions be continued, no further condensation is observable.

Now, introduce a little musk into the flask. If the musk gives off solid particles, cloudy condensation would at once take place when the air is expanded by drawing the handle of the air-pump, because the musk would keep up a constant supply of nuclei of condensation. But it is found that instead of that, the condensation is scarcely visible at first, and finally ceases, as if no musk were present at all. In consequence, it is determined that musk does not give off solid particles.

Varying this experiment, Dr. Aitken considered that, if musk passes into the air as a gas or vapour, it would be able to pass through a quantity of cotton-wool sufficient to stop all dust-particles. He first passed air over the musk, then through the cotton filter, with the result that the perfume came freely through the cotton-wool. Some of the gas which first entered the filter was trapped and held by the wool, but the wool soon became sufficiently saturated to allow the musk-vapour to pass. The trapped vapour remained in the wool and could easily be detected afterwards.

He also tested other odorous solid substances by the same simple apparatus, such as camphor and naphthalene. These both acted like musk and gave no nuclei of condensation, and the gas or vapour from both passed easily through cotton-wool. It is, therefore, safely concluded that they, like musk, evaporate in gaseous form. Quite conclusively, Dr. Aitken has similarly tested twenty-three substances; not one of them gave off their perfume in solid particles, nothing but gases or vapours escaping from them.

By repeated experiments, Dr. Aitken has come to a remarkable conclusion, which will be interesting to sanitarians, viz., that sewage does not communicate to the air any solid particles. The offensive emanation is a gas. The air in sewers is remarkably free from germs of all kinds, as they do not leave the sewage. If sewage gave off solid or liquid particles, these also would soon settle on the surface of the sewage. If, however, it be made to flow rapidly over falls, then both germs and particles of the sewage get mixed up with the air, but when the sewage flows without break in its surface film, the offensive emanation is in the form of a gas.

This revolutionary theory will take some trouble to crush. And it will in future save the sensitive feelings of those who have been unduly puzzled with the extreme division theory of matter in the case of conveying scent from the perfumed body.

Star Maps.

We regret that, at the last, it is not possible to bring out a star map supplement for this number. Not satisfied with the results of the process hitherto employed, we have been testing new methods, which, it is hoped, will give much better results. The trials, however, have not been completed in time for this month, although we hope with the December issue to continue the series.

Sugar.

By Dr. F. Mollwo Perkin.

Although the sweetness of most fruits is attributable to their sugar content, there are comparatively few which contain *saccharose*, the sugar which, in this country, is generally called *cane sugar*. Of all plants which contain saccharose, the largest quantity is found in the sugar cane, as may be seen from the following list:—

Sugar Cane *Saccharinum officinarum*	15 to 20 per cent.
Sugar Beet *Beta vulgaris* ..	8 ,, 18 ,,
Sorgo, *Sorghum saccharatum* ..	9 ,, 14 ,,
Pine Apple .. .	11 ,,
Sugar Maple, *Acer Saccharinum*	5 ,,
Strawberry	5 ,, 6 ,,
Apricots	3 ,, 6 ,,

It is also found in small quantities in some varieties of birch, palms, and in maize stalks. Most other plants contain either grape sugar (dextrose), or fruit sugar (laevulose).

Cane sugar seems to have been first known to the Chinese, at any rate, they knew of the sweetening properties of the sugar cane, although it is doubtful whether they actually prepared crystallised sugar. At the time of Alexander the Great, sugar was brought into Greece, and the Grecian doctors employed it in medicine for curing all kinds of disease. The crystallised sugar appears to have been first prepared during the 7th century A.D., and was manufactured in Persia in the 8th century. The preparation of sugar and the cultivation of the cane followed in the steps of "the conquering Moors," during the 9th and 10th century, when it was introduced into Sicily and Spain. Fig. 1., taken from an old engraving, shows the manufacture of cane sugar in Sicily in the year 1570.

In the 15th and 16th century it was introduced by the Portuguese and Spaniards into Madeira, Brazil, and the Spanish West Indies. From this time on the cultivation of the sugar cane in the tropical countries, and the production of sugar, became a greater and greater industry. Many refineries of the raw sugar, obtained from abroad, were set up in Europe, and continued to flourish for many years, until, in 1806, Napoleon prevented the importation of the raw product. This practically killed the cane sugar industry on the Continent, but it resulted in the initiation of the beet sugar manufactory, which to-day is playing such havoc with the cane sugar industry. In this article the cane sugar industry will be first dealt with, as it is of greater antiquity, and also because the methods employed are simpler than those in operation in the beet sugar manufactory.

The chief cane sugar producing districts are Cuba, Java, Manilla, Mauritius, the West Indies, Northern India, North America, Brazil, Japan, China, Egypt, and the Sandwich Isles. In India it is being introduced with the hope that the cultivation of sugar, and its manufacture, may, to some extent, take the place of the waning indigo industry.

The sugar cane, as has already been shown, may, under favourable circumstances, contain from 18 to 20 per cent. of sugar, but when the agricultural and climatic conditions are not favourable, the amount of sugar may not be more than 15 per cent., as, for example, in Louisiana. The sugar cane belongs to the

family *Gramineae*. The outside of the cane consists of a hard, woody envelope, the interior consisting of a spongy mass of cells, between which the saccharine sap circulates. The leaves form at the very hard nodes, and each node is furnished with an eye. It is from these eyes that the plant is propagated. The cultivated plant does not bear seeds, so it, therefore, cannot be reproduced except by means of cuttings. The wild plant, however, reproduces itself by means of seed, but the wild cane contains very much less sugar than the cultivated variety. Fig. 2 shows the sugar cane, A, the incrustation of wax on the epidermis, highly magnified; B, the floret.

When the cane has been harvested, the stubbles are left in the ground, and will again yield an abundant harvest, if the soil is kept in a good condition.

After the cane has been cut, it is taken to the mill, and should be crushed as soon as possible, because if left some time before crushing, the yield of sugar becomes less, and the quantity of glucose increases.

There are two methods for obtaining the sugar from the cane: 1, Crushing by means of heavy rollers; 2, Diffusion.

Milling, or Crushing Process.—The cane, after stripping off any foliage, is passed through heavy mills, which consist of cast-iron rollers; it is then soaked in

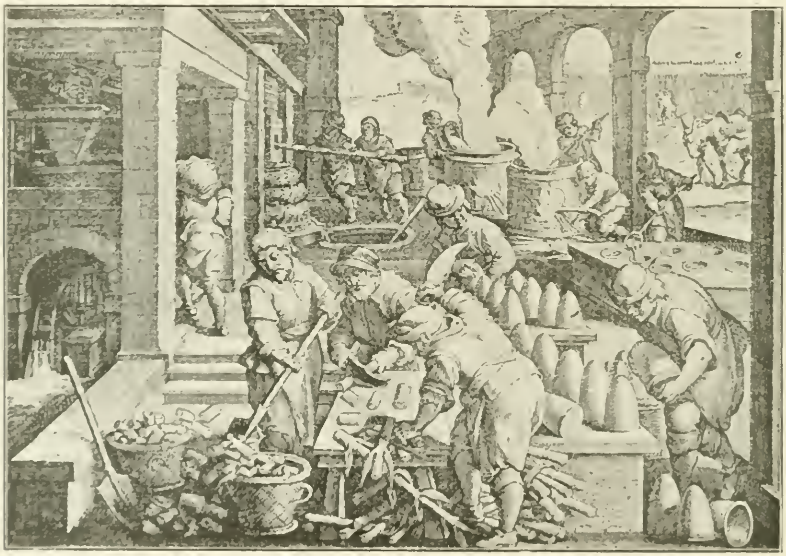


Fig. 1.

The pieces of sugar cane, about a foot in length, which contain the bud, or eye, are planted in furrows about six to eight inches apart; they are then covered with loose mould. After a period of from seven to twenty days, varying according to the variety of the cane, the age of cutting, and the weather conditions, the buds sprout, rootlets are sent into the soil, and the stalk and leaves begin to form. At the end of from 10 to 13 months, the cane has reached a height of seven to 15 feet, contains its maximum of sugar, and must be cut. If the cane is left too long, the quantity of sugar juice rapidly decreases.

For cane growing, the soil should be fertile and well tilled, but in a great many cases the growers neglect even the elementary principles of agriculture, keep their fields in poor cultivation, and without any manure whatsoever; they then seem surprised that they obtain a poor yield of sugar.

water, and again passed through a rolling machine. Although the pressure exerted is very great, yet, owing to the cane being more or less elastic, and the centre portion being of a spongy nature, as it passes from the rollers it immediately absorbs a portion of the juice which has been expressed, hence the necessity of a second crushing. Fig. 3 shows diagrammatically a section of a mill.

It consists of three cast-iron rollers, A, B, C, which are rotated by means of gearing, the speed of revolution being two to three revolutions per minute. D is an inclined table upon which the canes are placed, they pass down between the rollers A and B, and then along the inclined guide E, between B and C, the expressed juice running into collecting gutters. The crushed material, or *bagasse*, is carried by means of a conveyer, through washing tanks, and from these tanks to another series of rollers, or sometimes between two sets

of rollers. The bagasse is dried and used as fuel, because in most places where sugar cane is manufactured fuel is expensive and difficult to obtain.

The juice, as it comes from the presses, is sometimes an opaque straw-yellow coloured fluid, but is often of a greyish-green. It usually contains a considerable quantity of suspended matter, which requires to be

(*A*—Incrustation of wax on epidermis, magnified. *B*—Floret.)
Fig. 2.

separated, such as fibres from the cane, albuminous matter, sand, and clay, etc. Owing, however, to its slimy nature, filtration is by no means easy.

In order, therefore, to clarify the juice, it is treated with lime. There are two processes of liming, defecation—in which only a small quantity of lime is employed— and carbonation, where an excess is added, and afterwards removed by passing in carbonic acid gas. The addition of the lime neutralises the free acids in the juice, thus preventing inversion, *i.e.*, conversion of the saccharose into glucose, when it is subsequently heated, and it also combines with the albumen. All these insoluble materials enclose the solid impurities already in the juice, and carry them down as they are precipitated.

Before adding lime, the juice is heated in steam-jacketed pans to about 80°. Milk of lime is now added in the requisite quantities, the mixture is then brought to the boil, when a scum which contains many of the impurities, rises to the surface, and is skimmed off. The middle layer of the juice is found to be quite clean, the upper layer is turbid, and the lower layer contains the main portion of the precipitated matter. The three layers are drawn off separately, the upper and lower ones being passed through filter presses.

The defecated juice is now ready for concentration. The old and wasteful method was to heat the juice in a series of pans over an open fire. This was wasteful, because of the large amount of fuel required, and because of the possibilities of burning the syrup.

The syrup to-day is, almost invariably, evaporated in vacuum pans; the syrup from the beet always. The amount of fuel used in France, with the old, open-fire method, for 1,000lbs. of beets, was 400lbs., to-day, less than 100lbs. of fuel is required. The most modern and satisfactory system of evaporation in vacuum is known as the multiple effect, it was invented by the Franco-American Rillieux. The system is shown in Fig. 4. It consists of three evaporating pans, C, C, C, the condenser D, and the pump P. Steam at about 7lbs. pressure is let into the heating tubes of the pan furthest away from the pump—the tubes are covered with the syrup to be evaporated. The steam causes the sugar solution to boil. Owing to the vigorous boiling, and no condensation, there is not very much vacuum in this pan, but the steam from the evaporation passes into the heating system of the next pan, where there is a greater vacuum, therefore, the juice boils at a lower temperature. The steam from this pan now passes into the heating system of the last pan, which is under a very considerable vacuum, consequently, the juice boils at a much lower temperature, and the steam from it is continually condensed by passing into a well cooled condenser. All the pans are connected together by cocks, so that the juice can be run from one pan to the other. During the evaporation this is done continuously.

When the juice is sufficiently concentrated, it is pumped out of the last pan. During the evaporation many substances held in solution by the clarified juice separate out, so that the juice becomes turbid again. It is very important to remove these impurities, because they become enclosed in the sugar crystals during the subsequent boiling process. The juice does not filter well, so is usually purified by boiling the syrup in eliminating pans, and treating with caustic soda or sulphurous or phosphoric acid, as may be found necessary.

The next process is the boiling, or final concentration of the syrup. This is usually done in single exaporating pans. The syrup is drawn into the pan, which is generally of iron, and contains coils for heating purposes. The boiler requires to be a man of great experience, because the yield and grain of the crystal-

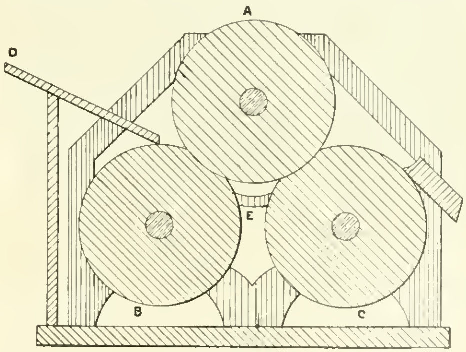


Fig. 3.

lised sugar depends entirely upon manipulation. It is not easy to explain shortly the manner in which this important process is carried out. For obtaining a sugar of average size grain, the procedure is essentially as follows: The syrup is drawn into the pan, which is under a vacuum of about 24 inches, the boiling point will then be about 60° (140° Fahr.). Steam is gradually

admitted into the coils as the syrup covers them. At the beginning boiling is very brisk, but as the concentration increases, it becomes slower. When the boiler considers the concentration sufficient, he lessens the supply of steam, and increases the vacuum, by this means the temperature of the contents of the pan fall to about 50°. The syrup is now supersaturated with sugar, and crystals commence to form. As soon as no more sugar separates, more steam is admitted, and a fresh quantity of syrup slowly drawn into the pan. When the pan is full, the supply of syrup is stopped, and the contents concentrated. The exact concentration, or striking point, has to be found by experience, and is determined by the firmness, a sample taken out of the pan by means of the proof-stick, acquires, when

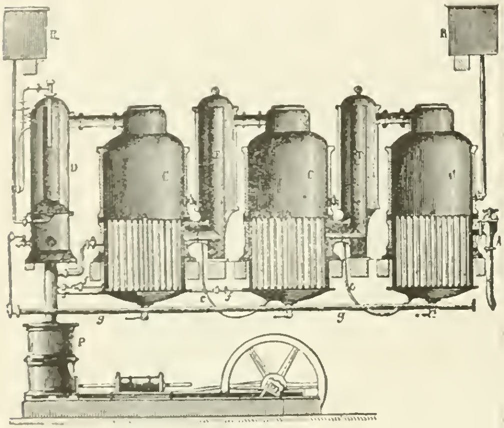


Fig. 4.

suddenly cooled in a pail of cold water. The mixture of crystallised sugar and molasses is now cooled, and then, after being stirred in a mixer for some hours to promote crystallisation, the porridge-like mass is centrifuged; this process removes the molasses, and leaves the hard crystals behind. The sugar is finally dried in revolving iron cylinders fitted with steam coils. It is then packed, and is ready for the market.

Diffusion Process.—The principle of the diffusion method is based on the property possessed by certain bodies, when in solution, of passing through a membrane; if on the other side of the membrane, a liquid is present, which contains a smaller quantity of the body in question in solution. This process of diffusion will go on until the concentration of the solution on both sides of the membrane is the same. Now, crystallisable substances, such as sugar, have this property, but gummy substances and albuminoid matter have not this power, or possess it to a very small extent. The process of diffusion is usually called dialysis. Now, in the living cell of the sugar cane, the protoplasmic tegument of the cell is not a dialytic membrane, but if the cell is killed, it then becomes a semi-permeable membrane, *i.e.*, is permeable to the one substance, but impervious to the other.

In the actual working of the diffusion process, the protoplasmic cell is killed by heat. The process is briefly as follows: The cane is cut up into small sections, which are placed into large vessels called diffusors, where hot water is poured upon them. The cells are killed, and then the sucrose, glucose, the acids, and certain inorganic substances diffuse through into the water. After a time, when a certain proportion of the sugar has diffused out, the sugary water is run off, and is replaced by a fresh quantity of water.

The first diffusion juice is poured on to a fresh quantity of slices, and this process of drawing off and pouring upon fresh slices is continued until the diffusion liquor finally becomes so far enriched that no further diffusion takes place. The juice so obtained is then concentrated and treated in the same manner as already described. The diffusion process is not used to any great extent in the cane sugar industry, although a very thorough exhaustion of the juice takes place.

A great advantage with the mills is that their capacity permits greater variations of output than is the case with the diffusion battery. For example, it is quite possible, in times of pressure, to crush as much as 600 tons per day with a milling plant only constructed to crush 450 tons. There are, however, advantages in diffusion, the extraction is more thorough, the juice is more easily worked, because most of the impurities remain in the *bagasse*, and finally there is less danger of breakdown than in the case of machinery. We will describe the diffusion process more exactly in its applications to the beet sugar industry, where it plays a most important rôle.

Exhausted Molasses.—A question of considerable importance to the sugar producer, is what to do with his molasses, which remain after the sugar has been separated, and from which a further quantity of sugar cannot be profitably extracted. A certain proportion of the better qualities can be used for treacle and golden syrup, but the manufacturer finds great difficulty in dealing with the major portion. If, in the neighbourhood, rum or arrach manufacture is carried on, then the most profitable outlet is to sell the molasses for the preparation of spirits.

The use of molasses as a fuel presents considerable difficulties. If it is burnt mixed with the cane refuse, at a comparatively low temperature, the charcoal chokes the grate, whereas at high temperatures the lime and other salts and the silica in the husks, form a kind of glass, which blocks up the bars of the grate, and prevents free access of air. In large factories special furnaces are sometimes built. The molasses are poured on an iron plate before the furnace, here they dry, and are then shovelled into the furnace. After the fire is once lighted, it goes on without more fuel, other than the dried molasses, and a fine ash, nearly free from carbon, is obtained. The ash is very valuable as a fertiliser, because it contains 35 per cent. of potash salts. It may also be used by glass-makers or soap boilers. In fact, it often pays to burn the molasses for the sake of its ash only.

It must be borne in mind that the process of manufacture here described is only concerned with producing Demarara or brown sugar. The further refining to obtain a fine, white, loaf sugar is a separate process altogether, and is not generally carried out in the neighbourhood of the sugar plantations. Large refineries are to be found, for example, in Liverpool and Greenock.

The manufacture of sugar from the beet root will be dealt with separately.

The diagrams, with the exception of Fig. 1, have been taken from "The Technology of Sugar," by J. G. Mackintosh; Fig. 1 from "Geschichte des Zuckers," by Lippmann.

THE TOTAL ECLIPSE OF 1905.

A joint meeting of the Royal Society and the Royal Astronomical Society was held on October 19 to receive the reports on the observations of the recent eclipse from the several parties sent out under the auspices of these Societies.

The Astronomer-Royal gave a full account of the doings of the expedition to Sfax, and exhibited some fine photographs; Prof. N. L. Callendar narrated his experiences in Spain, when a thick cloud entirely impeded observations; Mr. J. Evershed and Mr. H. F. Newall also gave accounts of their observations, the latter showing a series of interesting photographs; and, finally, Prof. H. H. Turner told of what was done in Egypt. On the whole, these reports may seem a little disappointing, as nothing at all of a novel or specially interesting character seems to have been observed or recorded. Some faint oval patches or rings in the corona just above the large prominence were noticed by Sir W. Christie, who suggests they are the results of a large and sudden explosion.

It seems a great pity that some of these fine photographs should not be published for the benefit of the astronomically-inclined public, especially considering that the costs of obtaining them were, to a large extent, defrayed out of public funds.

The following accounts from observers in different places should prove of interest.

At Alcala de Chisvert.

By Professor Marcel Moye *(University of Montpellier)*.

I observed this magnificent eclipse at Alcala de Chisvert, a little town on the oriental coast of Spain. I venture to say I was favoured by the Spanish skies The day before we experienced dull and wet weather, and hope was almost gone ; but at night the clouds broke away, and stars were glittering everywhere. At sunrise, however, an ominous strip of clouds was hanging on the south, and all the morning we watched them on the horizon—a rather painful watch.

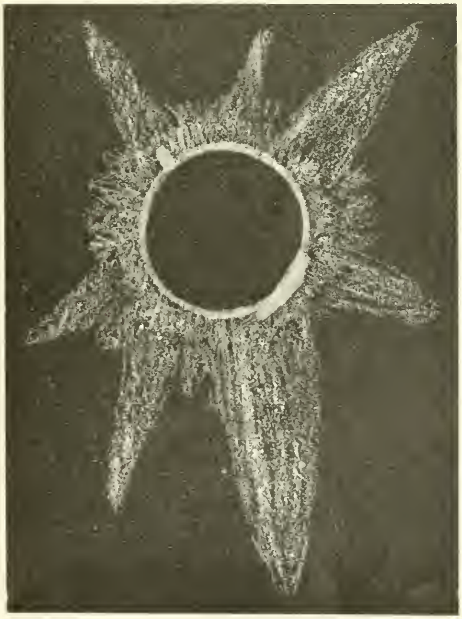
The first contact was seen in a perfectly pure sky, but, some minutes after, two or three cumuli went from the west, and slowly made their way before the sun. We were again almost in despair, but at the eventful moment the clouds were far north ; totality displayed its beauties without interference, except, at the end, for a light, transparent vapour of which I shall say a word later.

In order to secure good observations, I sketched for myself a very limited programme, and I had plenty of time to fill it without hurry. I intended to observe, 1st, shadow-bands ; 2nd, corona ; 3rd, general aspects of the eclipse.

Shadow-bands.—First as to shadow-bands. In the eclipse of 1900, at Elche, I had a good view of this phenomenon, and I was eager to see again these enigmatic bands. Here are my results.

I saw shadow-bands three minutes before and three minutes after totality, being unable to catch them during the total phase. They were greyish bands, not black, tolerably distinct and very wavy. Direction from south-west to north-east, and motion perpendicular, namely, from north-west to south-east, before and after totality. I must add that the wind—moderate—was blowing from south-west, and clouds went from west or west-north-west.

On the soil, white and smooth (the platform of the Alcala station), I had some rods with metric gradations. I estimated the width of the bands at two inches. and their distance apart at three or four inches. Their motion was slow, difficult to count exactly, perhaps one



The Corona as seen at Alcala de Chisvert, by Professor M. Moye.

or two inches per second. You will obtain a good illustration of the shadow-bands by stretching a rope by one end and making it waving with your hand by the other end.

For the observation of the corona, I used a good opera glass. I sketched carefully the coronal streamers, and I had time enough to compare my drawing with the eclipsed sun. The sun was encircled in a splendid ring, very bright, almost dazzling, of a white, silver hue, fading away softly in the darkness of the sky. This inner corona was lengthened by an intricate system of streamers, seeming as a whole an irregular star with six or seven points. Two groups of prominences were

evident, even to the naked eye, with a magnificent rosy colour, the brightest at the north-east part of the lunar limb, the other at the south-west part, almost diametrically opposite.

All the coronal rays were more or less of an ogival outline, or "angel's wing," as noticed in previous eclipses. Their bases were broad, and they were tapering and melting away in an imperceptible mode. Three of the streamers are worthy of special notice.

The north-east ray was exactly hanging over the beautiful prominence seen at its root. It seemed as an extension or, better, a sequence to the solar eruption. I must add, however, that at the south-west part of the lunar limb the second group of prominence was apparently without influence on the coronal forms.

The north-west ray was very long, perhaps one and a half lunar diameters. Curiously enough, its north boundary was very sharp, even on the lunar limb, and the inner corona was as rifted by a dark line and very conspicuous.

As to the southern streamers, they went so far as two lunar diameters (from the limb), and marked with certainty the greatest coronal activity. The eastern one of these streamers seemed double, or formed by two ogives overhanging.

The general appearance of the eclipse was, on a whole, less interesting than in 1900. Brightness during totality was surprisingly intense. I read without any difficulty small letterpress, and sketched my drawing very easily. All features of the landscape were evident, and the illumination perhaps greater than in 1900—recorded as a bright one. With the exception of Venus, I was unable to see any star or planet. Sky was grey, not dark, rather a neutral tint, especially in the north, with a yellow band on the south. Clouds remained unchanged. On the landscape everything was greyish, without reddish hue, the general appearance being very sorrowful, and conveying some impression of ashes-rain. I think the illumination, decidedly brighter than that of a full moon night, was in relation with the great activity of the solar envelopes.

The eclipse wind was very noticeable, coming to a standstill some minutes after totality. The fall of temperature (in the shade) was only 5° Fahr., but in the height of atmosphere it must have been greater, for, at totality, a thin vaporous veil (alluded to before) made its appearance round the rim. It was not a cloud, not being visible before and after, and not moving, but rather a condensation of the aqueous vapour by the coolness of the shadow.

A last word. The corona of 1905 was brighter than in 1900, and especially active at the solar poles, a typical form of a maximum year.

At Campo de la Isla, Burgos.

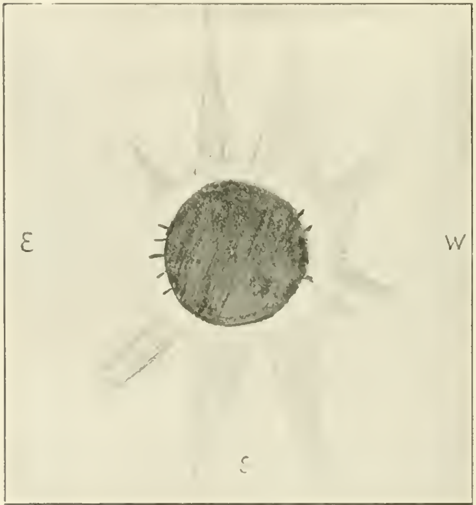
By C. NIELSEN, F.R.A.S.

Corona.—As per sketch herewith; inner ring very bright and about one-fifth lunar diameter in width; streamers faint and not extensive, longest about one and one quarter lunar diameters in length; colour pinky white. No vividness or sharp outline as at Ovar in 1900; became visible on West limb three or four seconds before totality.

Prominences.—Five large on East limb of usual bright cherry-red colour, except fourth from top which was somewhat paler (several persons reported to me that they had seen this and the chromosphere between 3rd and 5th prominences of a chemical green colour (? Coronium); possibility of complementary colour or colour-blindness eliminated by cross-examination); one of these prominences persisted an exceptionally long time before being covered up by the advancing moon; then two prominences in North-West quadrant followed two or three seconds later by an 8th in South-West quadrant, all of usual red colour, as was the chromosphere spendidly visible all round West limb.

Body of Moon appeared as disc—not as globe—of a dull grey-black colour.

Shadow not seen coming on, but very distinctly in drawing off over the distant 5,000 ft. high hills to East, taking a minute or more to reach horizon.



Copy of Sketch made Immediately after Totality on 30th August, 1905.

Colours of earth and sky round horizon ashen-grey, then yellow to orange gold, round sun reddish-purple; darkness much more pronounced than at Ovar, but clouds spoiled these observations greatly; temperature also changed little owing to same cause; wind westerly, force 3, sky clouded, though totality from a few seconds before to about one minute after was seen in a clear patch of blue sky.

Bailey's Beads—seen by me so clearly at Ovar—though carefully looked for, were not seen, nor was Mercury visible at all; Venus shone brightly through cloud openings several minutes before totality, and Regulus ditto, but no other stars glimpsed, though looked for in their proper places, being all covered by light clouds; returning light brighter than vanishing, but cloudiness also detracted from this observation.

Shadowbands distinctly seen travelling from West to East at rate of five to six miles an hour, distance between bands estimated at 30 to 40 cms., and width of bands themselves 8 to 10 cms.

Effect on Animals.—No birds visible; donkey brayed, sheep bleated, and cavalry horse galloped wildly about when totality began.

At Vinaroz, Spain.

By FATHER AUGUSTIN MORFORD.

I had been staying for some days near Bordeaux. I started for Spain from the Gare du Midi on Sunday evening, August 27, at 6.42, and reached Vinaroz at 2.45 p.m. on Monday, after a much less difficult journey than I had expected.

Father Cortie was at the station of Vinaroz. He took me to the fonda (hotel), where I slept during my stay, and to the house of Doctor Sebastian Roca, where we took our meals in common. Our observation ground was in a field of lucerne adjoining Dr. Roca's garden. A gap had been made in the wall of separation for our convenience.

Father Cortie had three instruments for photographing the spectra in different manners, and a camera, for the corona, of about 20 feet focal length.

I, having brought the only telescope, a refractor of 4 5-16ths in., and intending to make only visual observations, was appointed to give order to open and close cameras at the beginning and before the close of totality. My own observations were made with an eyepiece x 70; field 52′, with two crossed spider threads dividing the field into quadrants.

Wednesday began auspiciously. The sun shone and the clouds were dissolved in the warm air, though overhead at a great height some were thickening.

First contact was observed at 11.54. It had already taken place a minute or two.

I watched several sunspots as they passed under the black disc of the moon. They did not differ sensibly in colour, observed with a prism and a green glass.

Now began our anxieties. A cone of cloud was rising slowly from the S.W. At twenty minutes before totality our chance of an untroubled view did not seem great.

As I had to announce totality I paid great attention to Baily's beads. This phenomenon differed considerably from that of 1900. As then, I noticed the abscission and subsequent disappearance of the terminal portion of the southern part of the crescent. Mr. Chambers has quoted in his Astronomy Halley's description of this in 1715. A second time there was a division, again at the south end, but less distinct. The crescent fined down very much. A little way from either end it became narrower than at the ends themselves. They appeared almost lance-headed, slightly diffused on the edges. The running together of the beads was much less pronounced than in 1900. There were *two* remaining at a slight distance from each other—that to the south disappeared first.

I had been observing too closely during the last few minutes to pay attention to the clouds, and I had seen Baily's beads so distinctly that I never thought there could be any. But I slipped off the green glass, and it was evident something was wrong. The black disc of the moon stood out forward. Behind there was a bright but diffused light, which seemed to come from behind the moon. But no coronal detail could be seen, nor in the telescope did I see any the whole time. However, I had no time to lose. The chief thing I intended to do was to map down the positions of the prominences, red, white, or pale tint, with coloured chalks. Five splendid prominences were glowing brilliantly in the N.E. quadrant. I had grey writing paper with circles in pencil, divided into quadrants corresponding with the wires in the eyepiece. I got the positions of the prominences approximately correct, but it was difficult at first to say of what colour they were. At first they seemed white, then I noticed a faint tinge of red, as of vermilion much diluted with Chinese white. When the chromosphere appeared it could not be said to be red. The atmospheric condition evidently was answerable for this, and what I saw were the usual hydrogen prominences. None were in the least like the two shining white columns I saw at Ovar in 1900. All were somewhat plumy, or cloudlike, or arboreal in form. One of the latter shape had a double trunk.

Long before these prominences in the N.E. were covered by the moon's disc, one appeared *floating* with no attachment, not more than 30°, if so much, from the North Pole, in the N.W. quadrant. Others gradually revealed themselves, till I had mapped seven; in both quadrants 12. I saw none in the southern hemisphere. All were pale, but very brilliant. Those in the N.W. quadrant had, perhaps, a trifle more colour.

I found it useless to observe the corona with the telescope, so I had several good looks with the naked eye. Though there was a small thin cloud covering the sun, the corona was most brilliantly visible through it. It was not pearly or silvery white, nor was there any trace of colour. The moon was the blackest of blacks, and the corona the intensest of whites, and very bright. The full moon at the meridian was not comparable with it in tint or brilliancy. I thought of our Lord's garments at the Transfiguration, "candida nimis velut nix."

The diameter seemed about half a solar diameter broad. It was, of course, impossible to see any faint outlying parts. It appeared pretty equal in breadth all round, the edge bordered with aigrettes. For the last 10 seconds it was free from clouds, but I saw nothing to add to, or take from, what I have recorded.

I had to give the order to close cameras, so I watched carefully for the orange-red glow of the chromosphere. I saw no decided colour, but the western limb suddenly became so bright that in some alarm I called out "Close!" and in one second the sunlight appeared. Totality had lasted 3 mins. 25 secs., as against 3 mins. 36 secs. calculated.

The sunlight gained with extraordinary rapidity, by bounds, as it were, so that almost at once all impression of eclipse was gone. Before long one felt the sun beginning to scorch again in cloudless intervals. The temperature had been agreeably cool for some time before totality.

The darkness may be estimated by the following:—The grey notepaper on which I drew had a fairly dark circle in pencil, and cross lines about twice as broad and dark. The latter were clearly visible, but the former so little so that I found my red chalk marks were some within and some without the circle.

I heard from others that they had seen the undulating shadows. None of us had time to look for them.

There were no flowers and very few birds to observe. The behaviour of the latter was distinctly abnormal, as they were terrified by the discharge of bombs by a well-meaning person who hoped thus to break or scatter the clouds. This is commonly done (or attempted) in the case of thunder clouds, which are low. But as these bombs are loaded to burst at from 400 to 500 metres, and the clouds were enormously higher, their effect, as might have been foreseen, was *nil*.

The houses, mostly flat topped, were crowded with spectators, who applauded the eclipse so heartily that my signals and Father Cortie's counting of seconds were not too easily heard. As a spectacle, at least, the eclipse was highly appreciated by them.

Eclipse Shadow Bands.

During the recent total solar eclipse of August 30 there appear to have been numerous satisfactory observations of the shadow bands, and from the very definite nature of many of the reports now coming to hand, it appears very hopeful that some advance towards the determination of their causation may result. The following notes summarise some of the data supplied:—

Constantine (*Algeria*).—MM. Henri de la Vaulx and J. Jaubert, observing at a station about 660 metres above sea level, state that the bands were visible 20 seconds before and after totality; although subject to various irregular movements, it was found that on the horizontal plane their length was in the general direction—N.E.-S.W. During the shorter intervals of 7 seconds before and after totality a second series of shadows were noticed intersecting the first series, always at an angle of about 25°. These had a width of 6 cm. or 7 cm., with intervening clear spaces of 60 cm. or 70 cm. The direction of motion of the bands was regular and definitely determined to be west-south before the eclipse, and in the opposite direction after.

Tripoli (*Barbary*).—M. Lucien Libert observed the bands on a sheet of 25 square metres. They were first seen 6 minutes before totality, and had the appearance of alternate bands of light and shadow, displacing themselves in a direction perpendicular to their length. They were not absolutely sharp, and at intervals appeared serpentine, as if affected by the wind. The following summary is given of the directions of the bands and their movements:—

Time.	—	Direction of Bands.	Directions of Motion.	Direction of Wind.
h. m. s.				
2 39	First series of Bands	N 60° E or S 60° W	S 30° E	S 35° E
2 41 15	Second ,, ,,	N 80° E or S 80° W	S 10° E	S 43° W
2 51	Third ,, ,,	N 45° E or S 45° W	S 45° E	S 60° W

REVIEWS OF BOOKS.

Junior Course of Practical Zoology, by the late H. M. Marshall and C. H. Hurst; 6th edition, revised by F. W. Gamble (London: Smith, Elder, and Co., 1905; pp. xxxiv. + 490, illustrated; price 10s. 6d.).—The mere fact of a text-book having reached its sixth edition affords such all-sufficient and convincing evidence of its popularity and its fitness for its purpose that any commendation on the part of a reviewer is a mere work of supererogation. Nevertheless we cannot pass over the edition which Dr. Gamble has in so many ways made superior to its predecessors without adding one word of approval to this excellent and invaluable little laboratory manual. In every way it is admirably suited to the needs of the student; a feature in which it excels so many of its rivals being the specially distinctive type, of various grades, in which the different parts of the structure of each object described are printed. By this arrangement the student is enabled to find exactly what he wants at the moment without any vexatious delay; and although the arrangement of such details may seem a trivial matter, yet it is one of which only experienced teachers, like the lamented authors of the present work, are able to recognise the full importance and value. Another distinctive feature of the volume before us is the comparatively limited number of the illustrations; and although this may at first sight seem a disadvantage, it is in reality a great merit, since it compels the student to resort to actual dissection, and prevents him from trying to obtain his knowledge at second hand by merely studying figures of the labours of others. The only adverse comment we have to make in connection with a work in every respect admirable, is that we regret the editor did not see his way to conform to modern usage by substituting the name *Branchiostoma* for *Amphioxus*.

Extinct Animals, by E. Ray Lankester (London: A. Constable and Co., Ltd., 1905; pp. xxiii. + 331, illustrated; price 7s. 6d. net).—"A book that tells you exactly what you want to know about animals" was the comment made by a member of the present writer's family after perusing a copy of this profusely illustrated volume; and as this tribute came spontaneously from one of the "young people" to whom the author specially appeals, it may be taken as satisfactory evidence that he has hit the mark at which he aimed. Professor Lankester is indeed justly famed for his power of imparting information on abstruse subjects in a manner which, while thoroughly accurate and often detailed, yet arouses the interest of his hearers or readers to such a degree that, in place of being wearied, they are left with an overwhelming desire to know more about the subject under discussion. And as an example of this excellent—and indeed only true—way of teaching, the volume before us, which is a revised report of a series of lectures delivered by the author before a juvenile audience at the Royal Institution during the Christmas holidays of 1903-4, can hardly be excelled. Whether discoursing on the evolution of the elephant and the marvellous way in which the jaws of its ancestors were first lengthened to form a kind of "bogus" trunk, and subsequently shortened when the real article was developed, or discussing the strange fossil reptiles of South Africa and Russia and their relation to mammals, the author is equally successful in maintaining the interest of his subject and carrying his readers with him. Big animals apparently have a special fascination for the learned professor, and the reader is introduced in turn to the thigh-bone of the mightiest reptile that ever trod this earth, to the fossil tooth of a shark beside which the dental weapons of modern species are mere playthings, and to the longest and heaviest elephant's tusk ever put on the London market. Of course, a few holes may be picked here and there by the captious critic; and we doubt not that in a second edition the author will remove *Dimetrodon* from the Theromorpha (p. 212), while he will compare the tail of an ichthyosaur with that of a shark instead of that of "a fish" (p. 227), and will alter a certain sentence (p. 94), which, to our mind at any rate, conveys the idea that rhinoceroses possess trunks. Such little incidents detract, however, in no wise from the value and interest of a work which only a man of unusually comprehensive mind and great powers of generalisation could possibly have written, and which will certainly appeal to a much wider circle than the young people for whom it is claimed to have been specially written.

A Popular Introduction to Astronomy, by the Rev. A. C. Henderson, B.D. (T. & J. Manson, Lerwick; 2s. 6d. net).—This little book is exactly what its title implies. It is clearly and popularly worded, and tells just what those who have not made any study of the subject would mostly want to know. And there is no waste of words; almost every sentence contains a fact worth recording, and the facts are reliable. The book is quite up to date, mentioning Jupiter's 6th and 7th satellites. We can thoroughly recommend this concise little guide to all who wish to gain a grasp of the great science of Astronomy in an hour or two.

A Technological and Scientific Dictionary. Edited by G. F. Goodchild and C. F. Tweney (G. Newnes). Part X. (Pyr-San). 1s. each part.—A good explanatory collection of terms used in science is much needed, and this work, which is gradually being brought out in parts (and will be completed with the 13th), should supply the want. The definitions here given are mostly full and correct, and in some instances, such as under the headings of "Pyrrole," "Radio-activity," "Railways," "Rubber," and "Sanitation," articles of several columns are given. But it seems a pity that the line is drawn where it is as regards the classification of subjects to be included. Thus, though such subjects as music, painting, and even heraldry are fully treated of, military and naval sciences are not referred to (Range-finders, Rifles, Redoubts, Rockets, Sails and Sailing, &c.). We find the dress of the ancient Roman soldier and mediæval armour described (Sagum, Salade, &c.), but not the equipment or armament of the warrior of to-day; rapiers are defined, but not rifles. Various other subjects, too, which might well be included in the term "Technological and Scientific" are not gone into. Several words, such as *Rarefaction* (of air), *Repulsion* (motor), and *Réaumur* (thermometer scale), are conspicuous by their absence. We must hope that a full appendix will be added to include these omissions.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C Sc. (Lond.), F.R.P.S.

Variation of the Figure of the Sun.

In the early seventies Lewis M. Rutherfurd obtained a considerable number of excellent photographs of the sun at his private observatory, and these were later presented by him to the Observatory of Columbia University, New York. As it has been shown that stellar photographs taken by the same astronomer are capable of giving results comparable with the best heliometer determinations, Prof. C. L. Poor, of this Observatory, has lately been induced to examine the old solar photographs with the object of finding any evidence of changes in the form of the solar disc.

In all there are 139 photographs, extending over the period 1860-1874, but part of these were only with a small lens. Those taken from 1868-1874 were with his 13-inch telescope, and of these plates 22 have been selected as suitable for minute measurement, and on each the polar co-ordinates of twenty-eight points round the limb have been determined. Dividing these into two sets and taking means, it was possible to obtain a most probable value for the polar radius, and for the equatorial radius, of the solar disc on each plate. The differences of these radii are tabulated in order of time, and it is shown that there is a consistent agreement for the plates of any one year, but that the plates of different years differ radically. Thus the plates in 1871 show the equatorial radius to exceed the polar by some 0''·3, while the plates of 1870 and 1872, on the other hand, show the polar radius to be the greater by about 0''·2. A critical examination of the records shows that the instrumental conditions, time of exposure, orientation, &c., were as nearly as possible constant, and it must therefore be due to a real expansion and contraction of the sun's disc.

An interesting confirmation of these conclusions was then furnished by a discussion of the heliometric measures of the sun's diameter which were made by the German observers in preparation for the transits of Venus in 1874 and 1882. Professor Poor has arranged all these solely with respect to time of observation, and finds they readily fall into two series, one from September, 1873-January, 1875, the other from May, 1880-June, 1883. In both of these groups it was found that there was a progressive change, and that of the first group was in the same direction as that indicated by the Rutherfurd plates, while the second group was opposite. Thus during the interval from 1881-1883 the equatorial diameter was apparently growing longer in relation to the polar diameter, while during the former period, 1874-1875, the equatorial diameter was growing relatively shorter.

Again, photographs of the sun taken at Northfield, Minnesota, by H. C. Wilson, during 1893-1894, indicate a shrinking of the equatorial diameter with respect to the polar diameter.

On examining the epochs of these changes, it is at once apparent that they have a distinct relationship to the curve of sun-spot frequency, and on plotting the values there is good agreement as far as the observations go.

These investigations seem to show, therefore, that the ratio between the polar and equatorial radii of the sun is variable, and that the period of this variability is the same as the sun-spot period. The sun appears to be a vibrating body whose equatorial diameter, on the average, exceeds the polar diameter. At times, however, the polar diameter becomes equal to and even greater than the equatorial—the sun thus passing from an oblate to a prolate spheroid. It is possible that in this variable figure of the sun may lie the explanation of the anomalies in the motions of the planets Mercury, Venus, and Mars.

Polarisation Observations during the Solar Eclipse, August 30th, 1905.

A very interesting series of polariscopic determinations are reported by M. Salet, who was appointed by the Paris Bureau des Longitudes to observe the recent total solar eclipse at Robertville in Algeria.

His first effort was the endeavour to detect any existence of a magnetic field in the neighbourhood of the sun by observing if the plane of polarisation of the coronal light suffered any deviation. This plane should, from reasons of symmetry, be radial if no magnetic field existed in the gaseous atmosphere. For these observations an equatorial telescope of 95 mm. aperture was employed, furnished with cross wires and a Savart polariscope placed before the eyepiece. This can be turned, before the observation, so as to suppress the bands due to terrestrial polarisation. During totality the bands were well seen on the corona. The plane was found to be deviated in the right hand direction by 2° S. The smallness of this indicates that the sun has, in spite of its mass, only a slightly magnetic field.

With another apparatus M. Salet was able to obtain good photographs also of the coronal polarisation, showing fifteen bands on the width of the solar diameter. They are visible for about a diameter and a half from the solar limb, practically up to the edge of the external corona. The polarisation had a maximum intensity about 5′ or 6′ from the sun's limb, the plane of polarisation being almost radial, and the slight deviation measured visually was thus verified. A prominence found crossing two bands apparently suffered no change of intensity, showing without doubt the non-polarisation of the prominence light. On none of the plates is there any trace of atmospheric polarisation outside the corona or on the moon.

For comparison, several observations were made of atmospheric polarisation by means of two Savart's directed 90° from the sun, but at this distance no bands were visible during totality. At 30° or 40° from the sun, however, the bands were easily seen during totality. In the neighbourhood of the sun the plane of polarisation was vertical.

A spectroscope was also provided with half its slit covered by a nicol. The spectra obtained show different intensities on the two halves by reason that on one the reflected solar light is suppressed by the nicol. The coronal radiation, strong up to 4′ from the limb, is shown on both sides. Rays of hydrogen and calcium are also shown, and others which will be measured later.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

The Chestnut Flour of Corsica.

The chestnut is the wheat of Corsica, and its flour is used in the form of bread or polenta by the peasants throughout the island. The chestnuts are slowly dried over a small wood fire and stored until required for grinding. The mills are of the simplest construction and consist of a wooden water wheel whose axis turns a millstone which crushes the shelled chestnuts against a fixed stone. The cheaper grades of flour are of a dirty colour owing to the presence of particles of the shells, and contain between 11 and 12 per cent. of moisture. The composition of different varieties of the flour has been determined recently by M. Comte, who finds that chestnut flour closely approximates wheat flour in its food value. It contains about the same amount of starch, more fat and cellulose, but less nitrogenous substances (7 to 9 per cent., as against 12 to 16 per cent. in wheat flour). Chestnut flour attracts moisture very rapidly, and therefore soon becomes mouldy unless kept in air-tight vessels. It has also the drawback of being very refractory to the action of yeast, and thus producing an inferior kind of bread.

The Formation of Ozone by Ultra-Violet Light.

It has been shown that the ultra-violet light emitted by an electric mercury lamp produces violet colorations in glass containing manganese which are otherwise only produced very gradually by sunlight under normal conditions ("Knowledge and Scientific News," this Vol., p. 158). The ultra-

violet rays from the lamp have also a marked effect upon oxygen according to the results of further experiments made by Drs. Fischer and Braehmer. When pure oxygen is conducted through the lamp with precautions to keep the temperature low, a considerable proportion of ozone is formed, the yield increasing with the strength of the light up to a certain point and then diminishing. If the temperature is too high no ozone is produced, since that first formed is reconverted into oxygen. It is pointed out that these experiments support Warburg's view that the formation of ozone noticeable in silent electric discharges is due to the emission of ultra-violet light.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Age of the Earth.

PROFESSOR SOLLAS is always interesting, whether he is reading a paper, and laying himself open to the criticism of others, or whether he is criticising with sledge-hammer blows a paper given by one of his geological colleagues. But he takes criticism in good part, and it is well that he does, for he has given every opportunity for it in his "Age of the Earth" (Fisher Unwin). He does not exactly say how long the stratified deposits of the earth have taken in forming, but leaving aside the possibility of radium and other radio-active bodies acting in such a way as to upset all preconceived ideas on the subject, he gives us the total of twenty-six millions of years as the time which would have been necessary to deposit all our sedimentary formations, at the assumed average rate of accumulation of one foot in a century. In asking, how far does this period satisfy the demands of biology, although he is aware that eminent biologists are not wanting who share his opinion, he answers for himself, Amply. He might also have added that there are many who cannot share the opinion.

Thickness of the Earth's Sedimentary Formations.

Incidentally, it is interesting to note the sum total of the maximum thicknesses of the sedimentary deposits, so far as Professor Sollas has been able to discover them. He gives a total of 265,000 feet, or about fifty miles, at the base of which are the great American pre-Cambrian formations, Huronian, 18,000 feet; Penokee, 14,000 feet; Keweenawan, 50,000 feet; although there seems to be some doubt as to the thickness of the last-mentioned. It will be necessary for our text-book writers in future to have a care not to repeat the oft-quoted thickness of about a dozen miles of sedimentary rocks.

The Sun as a Non-Luminous Star.

Sollas quotes Kelvin's argument that the life of the sun as a luminous star is even more briefly limited than that of our oceans. This means that if the age of the sedimentary rocks is as already given, our oceans may have been formed fifty-five millions of years ago, and that after a short existence almost as boiling water, they grew colder and colder, till they became covered with thick ice. So the earth may have remained, frozen and dark, until in obedience to the growing splendour of the sun, the long night of the earth became banished, and the commencement of running waters was the beginning of the formation of the sedimentary rocks. Just one suggestion here. Is it altogether inconceivable that life may have existed in the heated waters of the earth in the days of the non-luminous sun?

The Radium "Apparition."

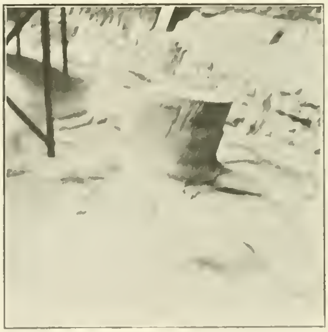
Professor Sollas speaks picturesquely of a new cause of disturbance, which looms up before us, "vague and gigantic, threatening to destroy all faith in hitherto ascertained results, and to shatter the fabric of reasoning raised upon them." This apparition is radium. If the earth possesses radium throughout its mass to the extent of one five-millionth of a gram per cubic metre, it has been asserted that the whole of the heat lost by radiation into outer space would be compensated for, and the temperature gradient would be unchanged for a very long period. So the geologist breathes freely again, and blesses the apparition.

Fossil Trees in Victoria Park, Glasgow.

Glasgow is fortunate in possessing, in its Victoria Park, the remains of an old carboniferous land-surface, which when laid bare showed a number of petrified broken trunks and roots of

Fossil Tree Trunk (Sigillaria), Glasgow.

Sigillaria. These have wisely been protected, and by the erection of a commodious shed over them, have been preserved from the effects of the weather. We reproduce some photographs of them. We know of no object-lesson so likely to



Fossil Tree Trunk (Sigillaria), Glasgow.

arouse interest in the study of geology as that presented by these easily-accessible specimens of a by-gone age. We plead for a better use of such specimens, and for a more general adoption of the study of geology in our Polytechnics.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Bee-eaters in Yorkshire.

THE *Zoologist* for October reports the occurrence of three Bee-eaters at Bentham, Yorkshire, during the middle of September. They had halted by the way in a garden, where they discovered a promising supply of food in the occupants of a number of bee-hives. On one of the number, an adult male, being shot, however, the rest appear to have moved off to safer quarters.

Hoopoe in Sussex.

Mr. J. S. Snelgrove writes to the *Field*, October 7, to say that he saw a Hoopoe on September 26 at Rotherfield, Sussex. The bird was sitting in a cart rut, but rose quickly and flew out of sight behind some trees. Doubtless we shall soon hear that it has been shot.

Common Quail in Ireland.

Mr. Allan Ellison gives a short account in the *Zoologist* for October of the re-appearance in some numbers of the Common Quail (*Coturnix communis*) in Enniscorthy, Co. Wexford, during July last. This note is of interest, inasmuch as for the past few years this bird has been rather scarce in Ireland.

Solitary Snipe.

Mr. A. R. Brooke writes to the *Field*, October 14, to record the fact that a Solitary Snipe was shot on October 6 in Pembrokeshire, but no particulars as to sex or weight are given.

An adult Great Snipe weighing 6 ozs. was shot at Snettisham during the last week in September. The average weight for this bird, we might remark, is about $7\frac{1}{2}$ ozs.

We learn from the *Field*, September 30, that a Solitary Snipe was shot "lately" in the middle of Ackergill Moor, near Wick. The age, weight, and sex of this specimen are not stated.

Greenland Falcons in Ireland.

The *Irish Naturalist* for October contains a note by Mr. H. J. Moran on the shooting of no less than eight examples of he Greenland Falcon on the West Coast of Ireland during this summer. Near Belmullet two females and an immature male were shot, while three others were seen of which one was trapped but escaped. At the Great Skellig an adult male and an adult and immature female were shot; at Crossmoline, Co. Mayo, another, sex not stated, was shot, while a young female was killed in Co. Cork. Expressions of regret for this slaughter are in vain.

Iceland Falcon in Co. Galway.

An immature female of this species was exhibited at the Dublin Naturalists' Field Club in March last, which was shot in Oughterard, Co. Galway.

Honey Buzzard in Norfolk.

The *Field*, October 7, records the fact that a Honey Buzzard was shot at Snettisham, in Norfolk, "recently." The bird was an immature specimen, and was killed in the act of rifling a wasp's nest.

Manx-Shearwater.

Mr. A. H. Patterson records in the *Zoologist* for October the finding of a Manx-Shearwater on the beach at Great Yarmouth, which appeared to have been dead some four days.

In the same journal is a record of the Manx-Shearwater in Worcestershire, one having been shot on a small piece of water near Bromsgrove on September 16.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Regularities in Spectra.

A NOTABLE advance has been made by Dr. Halm (Lecturer in Astronomy in the University of Edinburgh) in connection with the structure of spectra. Hitherto special formulæ have been needed in special cases to represent the series of lines which occur in spectra. Thus, for the lines on a "band" spectrum, Deslandres has used the formula $n = n_0 \mp am^2$ where n_0 is the frequency of the first line (the *head* of the band) and m is any integer; while, for line spectra, Kayser uses either the formula $n = a + bm^{-2} + cm^{-4}$ or similar expansions, and Rydberg the approximate formula $n = a + \frac{b}{(m + c)^2}$, where a, b, and c are constants and m is any integer. The different type of equation necessary for line or band spectra respectively seemed to indicate that these kinds of spectra were fundamentally different from one another. Dr. Halm has now shown that a single type of equation is sufficient for representing *all* spectra, and that it represents them much better than those previously used. This equation is

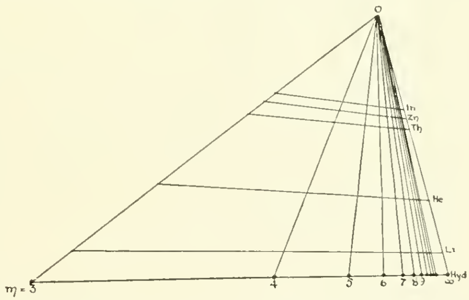
$$\frac{1}{N - n} = a\,(m + c)^2 + b$$

where N, a, b, and c are constants and (as before) m is any integer. When b is zero this equation is identical with Rydberg's; on the other hand when c is zero and b is very large compared with a, it approximates to Deslandres'. Curiously enough a formula, of which this is merely a mathematical modification, had already been employed by Thiele for band spectra; but he rejected it as inadequate. Halm shows that this rejection was unwarrantable and resulted simply from Thiele wishing the formula to do more than was necessary. In Dr. Halm's paper most known series are carefully worked out and adequately represented. For many cases the constant c is zero (it is so for 19 series out of 44). All the first subsidiary series (except Mg, Ca, Sr) belong to this group. In other cases c is usually a simple fraction, such as $\frac{2}{15}$. The occurrence of these groups shows that remarkable relations must exist between series of lines belonging to different elements, but of the same group. For example let n_x be the frequency of the xth line of a series, and n_x^1 that of the same line in any other series *belonging to the same group*; then if n and n^1 are any other corresponding lines in the same two series and e is a constant

$$\frac{1}{n_x - n} - \frac{e}{n_x^1 - n^1} = \text{constant.}$$

Hence if n_x, n_x^1 and the constants be known the whole of the second series can be calculated from the first. In this way Dr. Halm calculates eleven lines in the third subordinate series of Helium from the well-known Hydrogen series, for both of which c is zero. An interesting geometrical relation can also be exhibited. If we mark upon a straight line, on any arbitrary scale, the lines of a given series in such a way that the distances between two lines express the differences of the corresponding frequencies, and if from any point outside we draw straight paths through the points so selected, then the lines of any other series belonging to the same c-group can be represented as the points of intersection of those straight paths with a certain transversal line.

The following diagram will illustrate this theorem:—



On the base line the dots show the relative positions of the hydrogen lines corresponding to $m = 3, 4, 5 \ldots \infty$. From an arbitrary point O lines are drawn to these dots. The remaining lines have then been placed so that their points of intersection with the radial lines give correctly, on the same scale, the frequencies of the lines in one series for each of the following substances:—Lithium, Helium, Thallium, Zinc, and Indium. All spectra of the same group thus drawn would appear to coalesce if viewed from the point O.

In order to show that the formula is as valid for band as for line spectra, Dr. Halm calculates the wave lengths of the first triplet series in the *line* spectrum of Oxygen from the wave lengths of lines in the Cyanogen *band* spectrum!! The question of the regularities in spectra is obviously placed on a fresh footing.

Dr. Halm's paper appeared in the *Roy. Soc. Edinb. Transactions*, July, 1905.

[Since writing the above abstract I have discovered that this formula has previously been discussed by Professor Fowler, of the Royal College of Science, in *The Astrophysical Journal* for 1903. He shows there that it is the most satisfactory formula for line-spectra. He also applied it in *The Astrophysical Journal* for January, 1905, to the new triplets in the arc-spectrum of strontium which were discovered by him. He therefore has the credit of having anticipated Dr. Halm so far as line-spectra are concerned. He does not appear, however, to have applied it to band-spectra.]

ZOOLOGICAL.

By R. Lydekker.

The Connecticut Footprints.

Dr. R. S. Lull, of the Agricultural College at Amherst, in Massachusetts, has recently been devoting attention to the wonderful tracks of fossil animals in the sandstone strata of the Triassic strata of the Connecticut Valley, which have been known to the inhabitants for well nigh a century, and were described many years ago by the late Professor Hitchcock, President of Amherst College, who believed most of them to have been made by birds. Owing to the porous nature of the sandstone, very few of the bones of the ancient creatures which formed these tracks have hitherto been discovered, and for a long time indeed, none were known. The few skeletons that have been found indicate, however, that these tracks, as was to be expected, were made by dinosaurian and kindred reptiles, some of which walked on their hind legs alone, while others went on all four. One of these bipeds was a large carnivorous species, which left three-toed tracks of one type. Another dinosaur, of herbivorous habits, has also left footprints which are in most cases not very dissimilar to those of its carnivorous relative; but in places we find indications that the creature sat down, resting its tail and small five-toed front feet on the ground; thus proving that some at least of the four-footed tracks were made by animals which were normally biped. One type of four-footed tracks has, however, been proved to have been made by a reptile very similar to a crocodile in structure, but with the body carried high above the ground on long stilted mammal-like limbs. For this creature the name of *Stegomus longipes* has been proposed, but it ought surely to bear the title *Batrachopus gracilis*, bestowed long previously on its tracks.

British Dinosaurs.

In the July number of the *Geological Magazine* Baron Francis Nopcsa continues his restorations of British dinosaurian reptiles, dealing in this instance with the remains of a large carnivorous species from the Oxford Clay preserved in a private collection at Oxford itself. By most palæontologists these remains would be referred to the well-known genus *Megalosaurus*. Baron Nopcsa identifies them, however, with a reptile represented by a few bones in the Paris Museum, described under the name of *Streptospondylus cuvieri*, and states that this creature is distinguished from *Megalosaurus* by having four, in place of only three, toes to the hind feet. We await with interest the comments of Baron Nopcsa's fellow-workers.

Black Leopards.

Black leopards, like black jaguars and black pumas, are not a species of themselves, but merely a dark phase of the ordinary spotted leopard. It is, however, interesting to learn from India that the former animals, so far as the evidence from a single instance goes, when mated with individuals of their own kind breed true, although when crossed with the spotted race the offspring may be of either type. In the instance referred to two litters of wholly black cubs were produced by a pair of these dark leopards.

A Curious Squirrel.

A remarkably coloured new species of squirrel has recently been described from Upper Burma, under the name of *Sciurus harringtoni*. Unlike any other known member of the group, this species is of a pale creamy buff colour above, with the tail whitish and the under parts buffish. As two specimens were obtained, it is unlikely that we have to do with an albino form; and an adequate explanation for this departure from the normal type of squirrel coloration is therefore required.

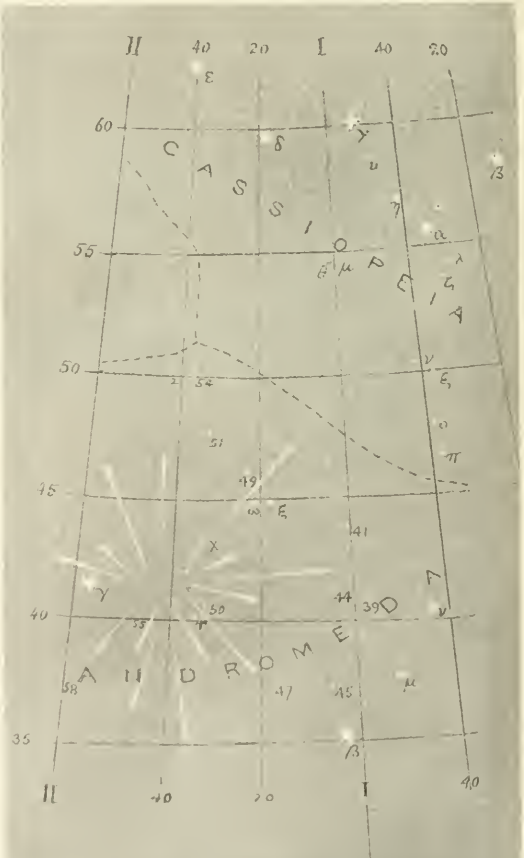
The Indian Palm-Squirrel.

Everyone who has visited India is familiar with the pretty little striped palm-squirrel, which is to a considerable extent a partially domesticated animal, or, rather, an animal which has taken to quarter itself in the immediate neighbourhood of human habitations. Hitherto it has been generally supposed that there is only one palm-squirrel throughout India. It has been recently shown, however, that there are really two distinct types, each with local modifications. The first or typical palm-squirrel, *Sciurus (Funambulus) palmarum*, inhabits Madras, has but three light stripes on the back, and shows a rufous band on the under-side of the base of the tail. In Pennant's palm-squirrel, *S. (F.) pennanti*, on the other band, there is a pair of joint additional lateral white stripes, making five in all, and the under surface of the tail is uniformly whitish olive. As this species has been obtained in Surat and the Punjab it is believed to be the northern type.

New African Antelopes.

A well-known German naturalist has recently described no less than twelve antelopes from East Africa as new; many being ranked as species and a few as sub-species, although we should be disposed to relegate the majority to the latter grade. Perhaps the most interesting feature in the communication in question is the naming of a new genus (*Rhynchotragus*) for those curious representatives of the tiny little antelopes commonly known as dik-diks in which the muzzle is produced into a kind of miniature trunk; *Madoqua guentheri* being the typical representative of this sub-group.

November Meteors.



The above is a Map of Region of the Andromedid Showers of Meteors which may be expected about 17-23 Nov., showing the radiant point. This Region is near the Zenith about 9 to 10 o'clock on those dates.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Pinatype.—This is the latest method of three-colour photography, the instructions and materials for which are issued by the colour works, formerly Meister, Lucius, and Brüning. Messrs. Fuerst Bros., of Philpot Lane, are the English agents. The method is, I believe, intended for the use of amateurs and those who make their own prints rather than for commercial work. The ordinary three negatives are made through a blue, green, and red colour-screen respectively. From each of these a transparency is made either by superposition or by common enlarging methods, and each transparency in turn furnishes a "print plate" by exposing beneath it a plate coated with gelatine and rendered sensitive by means of potassium bichromate. After due exposure the "print-plates" are washed, and, with or without drying, each is placed in a solution of the appropriate dye. The colouring matter is not absorbed where the gelatine has been completely hardened by the exposure, but it is taken up in the other parts, most copiously where there has been least exposure under the positive. The final print is prepared by squeegeeing a piece of "transfer paper" (gelatine coated) on to each "print-plate" in turn, with due regard to register, condition of moistness, and time that it is allowed to remain on the "print-plate," so that the amount of each dye absorbed by the "transfer paper" may be duly proportioned. The "print-plates" can be used as often as desired, preferably soaking them for a few minutes, each in its proper dye, solution, for each final impression. The resulting prints are finally placed for a minute or two in a solution, the formula of which is not stated, "to increase the pictures' fastness to light" and harden the gelatine, washed for about five minutes, and hung up to dry. The method is also applicable to the preparation of coloured transparencies.

The Royal Photographic Society's Exhibition.—As the Exhibition will be closed before this journal is published, my notes on it must be purely retrospective. It is very satisfactory to find that the practice of recording *changes* by photography is increasing. Not merely recording the phases of rapid motion, as in a series of photographs of a splash, but slower movements, as in the skin moult of a caterpillar, the germination of a grass seed, and the difference caused in an oak tree by fifty years of life. A mere photograph of a living creature is now common-place, unless the animal is rare; to secure attention some characteristic act or attitude must be shown, such as a flock of gulls alighting on the water, a robin eating a worm, or swans flying in anger at their assailant. A set of sixty lantern slides of mediæval baptismal fonts was medalled by the judges, because such work shows considerable sacrifice in the attainment of a specific object, and an object worthy of the sacrifice. A set of lantern slides should always have a definite aim, and if the aim is not obvious it should be stated by the exhibitor. The "pinatype" method of colour photography was demonstrated at the Exhibition.

Paper as used in Photography.—For certain photographic purposes, as in printing processes where the sensitive substance comes into immediate contact with the paper, and is, in a measure, absorbed by it, as in platinum and albumenised silver paper, it is necessary to have paper prepared with great care from pure materials. But when the sensitive material is prepared as an emulsion and applied so as to form a distinct layer, as in the usual printing out papers (P. O. P.), it is desirable to have a smoother and less absorbent surface than that of simple paper. For such purposes the paper receives a preliminary coating or enamelling, as of gelatine hardened with chrome alum, and coloured with a pigment, such as madder lake, or whitened and made more opaque by a white pigment, such as barium sulphate. But in order to get the most perfect impressions from half-tone typographic blocks with their minute and, therefore, shallow etched dots, a still more perfect surface is necessary, and this has led to the introduction of "art papers." From a communication made by Mr. R. W. Sindall to the Society of Chemical Industry and the discussion that followed it, we learn that "art papers" are coated on both sides with some inert mineral substance, such as china clay, barium sulphate and alumina, slaked lime and alum, or precipitated calcium sulphate, which is mixed with a sufficient quantity of an adhesive, such as glue or casein, to hold it together during the printing process without offering a too little absorbent surface to the ink. A coloured pigment is added if desired. Casein is largely used, and as it is insoluble in water, borax or ammonia is added with it to dissolve it, and a little formaline may be added also to get rid of any smell due to incipient decomposition. A heavy "art paper" may contain about 35 per cent. of mineral matter, and the thickness of the original will be increased by some 12 to 15 per cent. by the coatings.

A pure paper must present a very uneven surface, because of the irregularly overlaying fibres. The addition to the pulp of from 5 to 10 per cent. of mineral matter gives a rather smoother surface, and twice this amount gives a marked improvement. A so-called "imitation art paper" is better still and may contain 30 per cent. of mineral matter, though it is not applied as separate coatings as in the best "art papers," but put into the pulp, and brought to the surface to a certain extent by moistening the paper just before it is drawn through the rolls of the calender.

I suppose that an impression in black printer's ink is one of the most permanent kinds of record that can be imagined, but obviously its life is limited by the durability of the substance that it rests on. No doubt there is a tendency to consider that when the paper proper is to be sandwiched between two surfacing layers, it is not necessary to pay very much attention to its quality. But however this may be, it is certain that from a chemical and often from a physical point of view every increase in complexity means an added possibility of disintegration or decomposition. Gelatine (or glue) and casein are particularly susceptible to damp. In "art papers" the impression does not lie on paper at all but upon the surface of the coating. The preparation of a paper that shall satisfy the demands of the printer and at the same time be free from suspicion when regarded from its chemical and physical aspects, remains a very difficult if not an unsolved problem, but it is well to know how we really stand in this matter, that we may not regard only the permanent character of the impressions of our "reproduced" photographs, but also the resisting power to adverse influences of the material on which they are made.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Elementary Photo-micrography.

I have been frequently asked to give some information on photo-micrography which would assist absolute beginners. In endeavouring to act upon the suggestion it must be understood that these notes make no attempt to instruct those who are already more or less expert; absolute ignorance of the whole matter is assumed as a basis. For this reason, also, my remarks will deal with the mere elements of the subject only.

The first question that is invariably asked is whether a regular photo-micrographic camera is necessary. I am afraid that the answer must be in the affirmative. The main reason for this is that absolute rigidity and absence of movement is a *sine qua non*. An ordinary photographic camera could doubtless be fitted to an efficient baseboard by anyone with a mechanical turn, or who is used to carpentry, but the adjustments would be less satisfactory than in a camera made and designed specially for the purpose, whilst the cost of making such a baseboard and adding the necessary fittings and connections would go some way towards the cost of a proper camera. A further reason is that the ordinary camera has insufficient bellows extension. A modern photo-micrographic camera extends to at least thirty inches, and often to very much more. Of course, I have seen photographs taken with an ordinary camera, supported at the necessary height by books of the requisite thickness, but though they seemed to please their authors I am afraid they would not bear ordinary criticism.

The next question is as to the respective advantages of a horizontal and a vertical camera. Dr. Henri Van Heurck, the well-known diatomist, has done nearly all his work with a vertical camera, and there is much to be said in its favour. It is convenient to use; the microscope is in the upright position to which the observer is accustomed, and the adjustments of the microscope are thus more familiar to him, especially because he continues to use the mirror to reflect the light; it is easy to draw the camera-bellows up out of the way, to make most of the adjustments in the ordinary manner, and then to make the final connections, whilst if the camera is of the box type with a large door through which the head can be put to look down the microscope tube the matter is simpler still. Moreover, there are certain cases, such as those in which the object is but temporarily mounted, say, in water or otherwise, in which the microscope must be kept upright. But I think there can be no doubt that the horizontal camera is more satisfactory for all-round work, and, as a result, it is generally used and preferred. Its solid base gives complete rigidity, with, at the same time, every facility for long extension, and it lends itself in particular to the adjustment of illuminant and microscope with their intervening accessories, and more especially to the newer arrangement of optical bench, which has done so much to simplify and coordinate the necessary optical adjustments.

I do not propose to speak here of the more elaborate forms of photo-micrographic camera. I am writing for beginners, and, therefore, the simplest camera is the best for them. It must have a solid and steady base, and nicely turned legs must be conspicuous by their absence. The part of the base which supports the microscope must be long enough to hold not only the microscope, but the lamp or other illuminant, and there must be room between the two for condenser, cooling-trough, and stand for coloured screens. All these should be arranged on stands running between parallel guides so as to maintain their alignment with the optic axis of the microscope, whether they are brought forward or pushed back; the stands should be square and not round for the same reason, and there must be means by adjustable bars and by centring screws or otherwise of making the vertical and horizontal adjustments, which will be found to be necessary for each piece of apparatus, and which will prove an important factor in the results. The advantage of the optical bench is now evident. In its simplest form this is merely a heavy triangular iron bar, carefully planed, screwed to the baseboard of the camera, and carrying the light and optical accessories on saddle-shaped bases on its edge. As I have already said, this simplifies matters marvellously, *once the primary adjustments are made*, but a couple of parallel wooden guides make a quite efficient if less convenient substitute.

The camera itself will be raised a few inches higher than the rest of the baseboard, so as to bring its centre level with the centre of the microscope tube. It should extend to at least thirty inches, whilst many extend to sixty inches. The fittings of the camera will be described in due course; here I may just say that the light-tight joint may be nothing more elaborate than a loose sleeve of black velvet attached to the camera front and slipped over the microscope tube and held there in place by a rubber band or ring of elastic. A shutter must, of course, be provided.

The camera and baseboard must all be made of carefully-seasoned mahogany, and the camera must run smoothly and truely in its slides. The dark-slides, &c., should be constructed to take half-plate slides, and should have carriers to take quarter-plate slides as well. I need scarcely say that it is absolutely essential that the plates and the focussing screens must all lie at exactly the same distance from the microscope.

A camera of this sort can be obtained from all the leading opticians from £5 upwards, and both R. & J. Beck, and W. Watson and Sons make, in addition, the optical benches to which I have referred.

Let us now deal with the illuminant. Lamp-light—the light of an ordinary half-inch paraffin microscope lamp—is quite satisfactory for all but the most critical high-power work, but, of course, it needs a relatively long exposure. An inch lamp is better. The incandescent burner is not satisfactory—it gives a good light, but it is spread over too large a surface, and if it is focussed it gives an image of the texture of the mantle. Acetylene is really excellent, the light is good, it is small, and it has high actinic properties. The incandescent electric light is unsatisfactory, because the filament is too obtrusive; the electric arc-lamp is best of all, but, of course, can be indulged in by few who have not the run of a laboratory, and so for all-round work the oxy-hydrogen jet is the best for private workers. It is strong enough, and has sufficient actinic value to make the exposure as short as one need reasonably wish it to be.

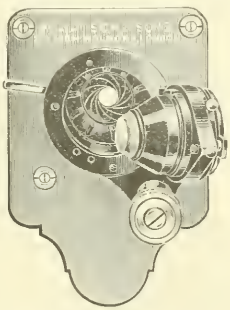
(To be continued.)

The "Ashe-Finlayson" Comparascope.

This instrument is the joint invention of Messrs. Ashe and Finlayson, and its object is to enable an observer to make an exact comparison of two different objects by showing them simultaneously in the same microscope field. The principle is quite simple. What is practically a second microscope is placed horizontally and at right angles to the optic axis of the microscope proper. This second microscope in its simplest form is a horizontal bar, carrying at one end an objective, and at the other end a mirror with universal movements, whilst between the two is a clip serving as a stage and moving by rack and pinion, the position of the objective itself being necessarily fixed. Between the nose-piece and objective of the microscope itself is screwed a tube about an inch long, with a hole at one side to which the auxiliary horizontal apparatus is attached. Inside this aperture is fixed a reflector of tinted glass, worked to a perfect plane on its upper surface, and placed at an angle of 45° to the microscope axis so as to reflect the secondary image upwards to the eye-piece. But in order to allow free passage of the light from the primary objective this reflector does not project more than half-way into the tube. Further, to prevent the overlapping and confusion of images, each set of rays is confined to its own side of the field of view by a removable division plate, which extends from the short tube containing the reflector to within an inch or so of the ocular, the tube being thus divided into semi-cylindrical sections, each of which transmits rays from a different object, and the image of which occupies different segments of the field of view. The inventors have also used a prism instead of the reflector, but have found the latter to be equally efficacious and more simple. The apparatus is made by Messrs. R. and J. Beck, Ltd., of Cornhill. It is quite simple to use.

Watson's Bactil Microscope.

Last month I called attention to a new microscope by Messrs. W. Watson and Sons, which, whilst conforming outwardly and in appearance to the Continental model, retained many of the principles which distinguish the English stand, more especially the lesser fine adjustment. An elaborated form of this microscope, which is to be known as the "Bactil," possesses



one or two additional features that are worth a further note. A mechanical stage can be made either detachable or as an integral part of the stand. In the former case it is very liable to deteriorate in its working parts and to fail in rigidity, and in the latter case it suffers when rough work is being done. In the "Bactil" microscope the horizontal movement works above the stage and is attached to it by thumb-screws so as to be removable, whilst the vertical movement is fixed below the stage, out of harm's way, and is non-removable. Incidentally the long range of movement of the detachable form of mechanical stage is thus attained. The other noticeable feature in this microscope is the fitting, when required, of a coned condenser, carrying the iris diaphragm, which can be readily turned down out of the optic axis if necessary. The arrangement is very similar to that already seen on some Continental stands, notably one of Zeiss', and was first introduced, I believe, on an English stand by Messrs. Ross. The subsidiary iris diaphragm immediately beneath the stage always seems to me, however, somewhat unnecessary.

Notes and Queries.

Major E. F. Beecher, Cheltenham.—I shall be very glad to give you any assistance in my power, but I am afraid I cannot advise you unless I know more definitely the nature of the investigations you wish to make. Histological methods vary greatly according to the end in view, and a fixing or staining agent that would serve one purpose might be quite useless for another. If you will let me know exactly what investigations you wish to carry out, I will try and make some suggestions as to how to set about them.

H. Cliff, Stafford.—The best book dealing with vegetable parasites is Tubeuf's "Diseases of Plants," translated by W. G. Smith, and published by Longmans in 1897. A very elementary and simple little book is M. C. Cooke's "Rust, Smut, Mildew, and Mould; an Introduction to the Study of Microscopic Fungi," published by W. H. Allen and Co., but I am not sure whether this is not now out of print. Second-hand copies are quite easily met with, however, and would not cost more than a few shillings. With regard to insect parasites on plants, you might get Miss Ormerod's "Manual of Injurious Insects." I am afraid none of these will give you much information as to preparing objects for the microscope, but I shall be glad to help you so far as I am able if you get into any difficulty.

A. H. Glaister, Darlington.—As far as my inquiries go, it seems very improbable that *Merulius lacrymans* forms resting-spores of any kind, and indeed it would be contrary to anything that has hitherto been observed with regard to the whole group to which this fungus belongs. The specimens you sent were not sufficient to pronounce an opinion; but it seems doubtful whether the fungus you have been examining is really *Merulius.* Under any circumstances the conditions under which you have made the cultivation have vitiated any trustworthy results, as your observing "swarm-spores" (which might be mycomycetes or infusoria!) shows the culture to be contaminated. I think, therefore, it may be assumed that the spores which you have observed are really those of some other fungus. I am glad you succeeded in resolving *amphipleura pellucida* with oblique illumination, but if mounted in a medium of sufficiently high refractive index it ought to be resolvable with axial illumination with an immersion lens of 1·25 N.A. The condenser should be carefully centred, the edge of the lamp flame focussed rigidly upon the diatom, and then the condenser should be racked up the merest trifle within its focus.

A. Rowland, Newport.—There is an excellent book on *Chironomus*, by Miall and Hammond, published by the Clarendon Press, in 1900, which is a model of what such a book should be and gives explanations as to methods. With regard to the general structure of Bees you had better refer to Dr. Sharp's volume on "Insects," part ii., in the Cambridge Natural History. I am glad you found the note on glycerine mounting helpful. I do not think caoutchouc cement would be satisfactory for glycerine mounts.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.53.

The equation of time is a maximum on the third, the Sun being 16m. 20s. before the clock.

Sunspots and prominences are numerous; at the time of writing several fine groups of spots are visible on the solar disc.

The following table gives the position, angle of the Sun's axis, and the heliographic latitude of the centre of the Sun's disc:—

Date.	Axis inclined from N. point	Centre of disc N. of Sun's Equator.
Nov 1 ..	24° 41′ E	4° 12′
,, 11 ..	22 33′ E	3° 7′
,, 21 ..	19° 45′ E	1° 55′
,, 30 ..	16 57′ E	0° 49′

THE MOON:—

Date.	Phases.	H. M.
Nov. 4 ..	☽ First Quarter	1 39 a.m.
,, 12 ..	○ Full Moon	5 11 a.m.
,, 20 ..	☾ Last Quarter	1 34 a.m.
,, 26 ..	● New Moon	4 47 p.m.
,, 10 ..	Apogee 252,500 miles	0 48 p.m.
,, 25 ..	Perigee 223,000 ,,	4 12 p.m.

OCCULTATIONS.—The following are the brighter occulted stars visible from Greenwich. It will be noticed that the 1st magnitude star Aldebaran is occulted on the 13th, disappearance taking place about 1 hour after moonrise.

Date.	Star's Name.	Mag.	Disappearance. Mean Time.	Angle from N. point.	Reappearance. Mean Time.	Angle from N. point.	Moon's Age.
			p.m.		p.m.		d. h.
[illegible]	[illegible] Sagittarii ..	[illegible]	6 [illegible]	14[illegible]	[illegible] 29	2[illegible]7	4 12
[illegible]	[illegible] Capricorni ..	[illegible]	1[illegible]	8[illegible]	1[illegible] 55	232	7 16
[illegible]	[illegible] Aquarii	4	1[illegible]	75	12 4	24[illegible]	8 16
[illegible]	[illegible] Piscium	[illegible]	7·[illegible]	[illegible]5	8 12	273	10 13
[illegible]	[illegible] Tauri	1·1	6 35	3[illegible]	7·1[illegible]	2[illegible]	16 12
[illegible]	[illegible] Tauri	[illegible]4	[illegible] 49	75	7·44	2[illegible]4	17 12

THE PLANETS.—Mercury (Nov. 1, R.A. 15^h 12^m; Dec. S. 1[illegible] 7′. Nov. 30, R.A. 17 55 ; Dec. S. 25 33′) is an evening star in Scorpio at greatest easterly elongation on the 27th, when he sets at 5 p.m. This elongation is very unfavourable on account of the great southerly declination of the planet.

Venus (Nov. 1, R.A. 12 51^m; Dec. S. 3 44′. Nov. 30, R.A. 1[illegible]; Dec. S. 16 2[illegible]′) is a morning star on the confines of Virgo and Libra. The planet is not well placed for observation.

Mars (Nov. 1, R.A. 1[illegible] 17; Dec. S. 24 6′. Nov. 30, R.A. 20 49; Dec. S. [illegible] 1[illegible]′) is visible in the S.W. for a few hours after sunset, but as the apparent diameter of the planet is now small, it is not a very suitable object for observation in small telescopes.

Jupiter (Nov. 1, R.A. 4 1[illegible]; Dec. N. 2[illegible] 0′. Nov. 30, R.A. [illegible]; Dec. N. 1[illegible]) is describing a retrograde path between Aldebaran and the Hyades. The planet is very favourably placed for observation, being in opposition to the Sun on the 24th, and is the most conspicuous object in the evening sky looking S.E. The equatorial diameter of the planet on the 25th is 49″·4, whilst the polar diameter is 3″·2 less. The following table gives the satellite phenomena visible in this country, before midnight:—

Date	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.	Date	Satellite.	Phenomenon.	P.M.'s. H. M.
Nov				Nov				Nov			
1	I.	Ec. D.	9 7	10	I	Oc. R.	8 1	23	II.	Sh. I.	9 7
	I.	Oc. R.	11 51	14	III.	Oc. R.	7 41		II.	Tr. I.	9 10
2	I.	Tr. I.	6 57	16	II.	Sh. I.	6 29		II.	Sh. E.	11 42
	I.	Sh. E.	8 30		II.	Tr. I.	6 55		II.	Tr. E.	11 42
	I.	Tr. E.	9 8		II.	Sh. E.	9 4	24	I.	Oc. D.	9 17
3	III.	Sh. I.	11 15		II.	Tr. E.	9 26		I.	Oc. R.	11 29
7	II.	Ec. D.	9 31		I.	Sh. I.	10 11	25	II.	Ec. R.	6 28
8	I.	Ec. D.	11 1		I.	Tr. I.	10 24		I.	Tr. I.	6 32
9	II.	Sh. E.	6 26	17	I.	Ec. D.	7 25		I.	Sh. I.	6 34
	II.	Tr. E.	7 11		I.	Oc. R.	9 45		I.	Tr. E.	8 44
	I.	Sh. I.	8 17	18	I.	Sh. E.	6 53		I.	Sh. E.	8 47
	I.	Tr. I.	8 41		I.	Tr. E.	7 1	26	I.	Ec. R.	5 57
	I.	Sh. E.	10 3[illegible]	21	III.	Ec. D.	9 11	30	II.	Tr. I.	11 25
	I.	Tr. E.	10 52		III.	Oc. R.	10 57		II.	Sh. I.	11 45

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Nov. 1, R.A. 21^h 56^m; Dec. S. 14 19′. Nov. 30, R.A. 21^h 59^m; Dec. S. 14 0′) is best observed immediately after sunset, being due south at 6.20 p.m. on the 15th. Telescopically, the planet with his rings is a beautiful object, and on account of his low altitude the position for observation is a most comfortable one. The apparent diameter of the ball is 16″·0, whilst the major and minor axes of the outer ring are 39″·6 and 7″·9 respectively, the ring appearing well open.

Uranus (Nov. 1, R.A. 18^h 6^m; Dec. S. 23 42′) sets shortly after the sun, and hence is not available for observation.

Neptune (Nov. 1, R.A. 6^h 44^m; Dec. N. 22 5′) rises about 7 p.m. near the middle of the month, and is due south about 3 a.m. The planet is situated in Gemini in a region rich in small stars, thus making identification somewhat difficult in small telescopes.

METEORS:—

The principal showers of meteors during the month are the Leonids and Andromedids; the Moon will somewhat interfere with observation of the former, but the latter shower occurs in the Moon's last quarter; moreover, the Andromedids may be numerous this year.

Date	Radiant. R.A.	Radiant. Dec.	Characteristics.
Nov. 14-16	150	+ 22	Swift, streaks. (GREAT LEONID shower)
Nov. 17-23	25	+ 43	Very slow, trains. (GREAT ANDROMEDID shower)

Minima of Algol may be observed on the 13th at 9.7 p.m., and 16th at 5.56 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—η Cassiopeiæ 0^h 43^m, N. 57 17′, mags. $3\frac{1}{2}$, $7\frac{1}{2}$; separation 5″·7. Binary star.

γ Arietis 1^h 52^m, N. 23 [illegible], mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei 2^h 44^m, N. 55 28′; mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

SUPPLEMENT.

[*Although it has not been usual to include fiction within the pages of* "Knowledge," *the following discourse, which is but a tale built around a new and possibly important scientific proposition, seems to be one not inappropriate to the contents of a scientific journal.*—Ed.]

London's Transformation.

A Suggestive Sketch of Days to Come.

By Tems Dyvirta.

CHAPTER I.

Introductory.

London! That vast city sheltering so many millions of human beings, a far greater population than any town at any time has contained. London, that province of brick and mortar covering an area more extensive than that of any other two cities. London, the great capital of the British Empire, which is the largest, wealthiest, and most powerful nation the world has ever seen. The central point of the land surface of the globe, the link 'twixt the old world and the new. Truly the "hub of the universe," if there be one.

A recent writer affirms that "Within the next ten years there will have been added to London a greater number of costly and important new buildings than in any similar period since the re-building of the City after the great fire of 1666." An extra half million of inhabitants will have to be housed, besides those who have been turned out to make way for the great Government and other buildings already planned.

Can the life of London last? With an ever extending Empire, growing richer day by day, to provide for; with trade and revenue increasing in proportion; with a population doubling in half a century, the heart which gives it life, the brain which gives it power, the counting-house of its central management cannot extend its bounds without unwieldiness, except by the adoption of some sweeping measure, such as the Tushian scheme.

But, fortunately, so beneficial a design, effectually neutralising present overcrowding, would extend London's life.

Yet this vast collection of buildings is but a sorry city. It is, whatever may be said to the contrary, but a collection of towns. There is no centre, no one High Street from which others radiate, no district to contain all the chief buildings. It is an animal without a backbone, a tree without a stem. The streets are narrow and overcrowded. The main arteries are congested with traffic, and owing to lack of being systematically laid down, have to be continually "up" whenever the drains and wires buried under them receive attention.

Good healthy house accommodation, too, is wanted, the slums need re-building, but they will not be rebuilt so long as land is so scarce.

Moreover, it is a dirty place and is cursed with a chronic fog, which chokes the lungs of its dwellers, which darkens and saddens the homes it contains, and which is said to cost at times from £50,000 to £100,000 a day in extra illuminants and in other ways. And this fog is attributed to the murky river and its damp bed, which traverses the great city.

In one of the latest books on Meteorology* we read "In a city like London or Glasgow, where a great river, fed by warm streams of water from gigantic works, passes through its centre, fogs can never be entirely obliterated."

A river running through a populous town cannot be healthy. All the filth is washed down into the channel and becomes collected there and its offensiveness disseminated.

And this same river, too, not properly kept in hand, has a way now and again of getting above itself and flooding the low-lying streets. Everyone will remember (or, at all events, those that were in London at the time now being referred to) the awful catastrophe that occurred in the Underground railway about this time. It may be as well to recall the main facts. Some drainage operations were being executed on the Embankment, when an unusually high tide swept away some stones in the Embankment wall, which had probably long been slightly displaced. The water rushed through and flooded the excavation, and, washing away the earth around, at last burst in the brickwork of the tunnel of the Underground railway. This had most appalling consequences. Several trains were stopped. The water rapidly rose in height, some of the passengers clambered on to the tops of the carriages, while others waded and swam to the nearest stations. But it was all in vain, for the tide was at such a height that the level of the water reached far above the platforms, and only a very few persons succeeded in getting up the steps. And, what was worse, the raging torrent rushed along the line for miles, and soon found its way into the "tube" railways, where again whole train-loads perished. It proved to be the most terrible catastrophe that ever occurred in London.

Then if we go further afield it is surprising to find that poor little ditch, the Thames, whilst greatly prized

* By Dr. J. G. McPherson

and justly celebrated as a recreation ground for boat-loving Englishmen, yet above bridge so narrow and crowded, below so dirty and overrun with shipping.

And even here we are threatened with the possibility of further disasters. Has anyone calculated what would be the consequence of the river, say at Eton, rising three feet higher than it has done? Owing to the gradual contraction of the banks and wharfs in London preventing a free flow, a sudden great rise, such as might be caused by an abnormally heavy rainstorm, would certainly have most disastrous consequences on the towns and villages of the valley of the Thames, and many thousands of pounds' worth of damage would certainly be done, and there would be great probability of a serious loss of life.

One more matter regarding this London and its river. What if an invading army were to land in England and advance against it? Military geniuses are full of their schemes for erecting forts on the hill tops of the North Downs, but recent authorities tell us that a river is the most efficient barrier, when properly guarded, to the progress of an invading force. Yet where is the desired river? The Thames, as it is, does us no good in the defence of London.

But enough of this commentory on the wonders and on the ills of London, and the Thames, and let us hear how a great change came about at a period not very clearly located in the annals of the century.

CHAPTER II.

CORNELIUS J. TUSH.

In one of the busiest corners of this busy city a small group of men might have been observed. The one on whom our attention must be fixed is a middle-aged, rather short, clean-shaven man, with clear-cut features, typical of shrewdness, if not cunning. His clothes have the appearance of being well cut, and even show signs of dandyism and a display of wealth. Yet on closer examination they will be seen to be old and well worn, and should have been discarded ere this by a wealthy beau. Note, too, the face. Is there not a shade of disappointment? Are there not evident traces of failure and mental suffering? And who are his companions? Just the ordinary typical City men, but evidently from their manner they hold our friend in [illegible] reverential awe. Having finished their confabulation, they respectfully take off their hats and pass away. "[illegible]!" called this man to one of the group, who at once turned back, "Remember! don't mention my arrival in this country till the appointed day. Meanwhile I [illegible] you know what to do." "Very good, Mr. Tush," responded the other, "trust me." So they parted and Mr. Tush wended his way back right through the City, and on, [illegible] and pensively, to the south of the river. Still onward he goes towards Lambeth, up one small street and down another, picking his way in the [illegible] for his delicately-made boots are worn and [illegible]. There is much mud here, too, for an exceptionally high tide has caused the river to overflow, and [illegible] the streets have been almost impassable. He turns up the steps of an ordinary-looking little house, over the front door of which is a fanlight and a card inscribed with the word "Apartments." Our friend knocks on the rusty knocker, and a stout old female, with sleeves rolled up and a dirty apron covering her portly front, opens the door. A smile beams on her fat face as she recognises the visitor, and taking from a small shelf two or three letters, she hands them to him. The letters bear the inscription "Cornelius J. Tush, Esq.," followed by so many addresses scratched out and re-directions put in that the poor postman must have offered a silent deprecation as he endeavoured to decipher the desired destination of the missives.

Cornelius J. Tush! Can this be the great American millionaire? He with the world-wide reputation for vast wealth and keen sagacity in all commercial enterprises? He, the clever son of the great "Button King," Abraham Tush? Aye, verily! but what a come-down. His history of the last few weeks is easily written. He had been living in domestic happiness and luxury in his home near Philadelphia, when affairs began to go wrong. His great scheme of the Grand Central Railway had failed. The Pacific Canal was not yet near completion, although absorbing millions of his invested dollars. The inventor he had set to work to experiment on a large machine, which was to have revolutionised the world's methods of travel, had at last to acknowledge that he was completely baffled after expending some 500,000 dollars in experiments. One thing after another had gone wrong, and Cornelius had to own to himself that he was a ruined man.

Frantically he endeavoured to struggle against the rising tide. All kinds of wild schemes did he propose to his erstwhile disciples, but all New York had become suspicious, truth will leak out; and though no one, of course, knew exactly where Cornelius' money lay, or in what quantities, dark rumours began to spread abroad, and people shook their heads and said to themselves, "Avoid Tush." It was, indeed, a time to make a man think; but Cornelius was a determined character, and the more hopelessly he found himself sinking in the mud, the bolder and more pretentious were his schemes. He thought of his father's methods, which were to go in for that which will sell by the million, never mind what it is or how small the article, so long as it sells by millions. "Now look at buttons," he used to say, "why, every man on the face of the globe, or no, every *civilised* man, has a dozen on each of his trousers alone, and, then, look how easily they are lost!" Why can't one think of something new, something that everyone needs, invent a boot sole that won't wear out, or a new food that everyone would eat?

Well! New York was played out, and with it all commercial America. But the name of Tush was well-known in England, and here, possibly, the sinister rumours had not filtered through. He would see if a 'cute Yankee could not "bluff" the Britishers. No sooner thought of than the plan was put into execution, and Cornelius bade a touching farewell to his young wife, the beautiful Alma Dalvine, and his little only daughter, Libertia, and took the boat to seek his fortune on the far side of the herring pond.

Arrived in London, Cornelius set to work to carefully reconnoitre his ground. He had managed to bring away, as almost the last remnants of his great fortune, what most people would call a good round sum of ready money, but this would require to be very carefully expended, and he had determined to be as economical as possible so as to have the more when the time came for definite action.

So for the first week he "lay low" in his miserable lodgings in Lambeth, deciding that when all was ready he could "cut a dash and set things humming."

But first of all it had to be noised abroad that the

great Cornelius Tush was coming over to London with a view to investing some of his millions in whatever took his fancy. He proposed, then, getting into a few big (if risky) undertakings, and selling out his shares before paying for them. His was a name to conjure with and he a good prestidigitateur. Bateson, a man with a great reputation for shrewdness in business, though for nothing else, was acting as his chief agent in the matter. London happened to be in the right state, too. An air of speculation was rife in the City. Things were prosperous, and new schemes were finding favour.

Having then got the news about that he was shortly to arrive, the great man was to appear upon the scene; not, of course, as the sordid, broken-down failure, but as the American Crœsus, with so much money that he didn't know what to do with it all. Then he would make a great display of wealth so as to bear out his reputation, and thus would he take the place by storm, and become again, in fact, a multi-millionaire.

CHAPTER III.

The Dinner.

This much, then, had been done, and Cornelius was now about to issue forth from his chrysalis state into the splendid butterfly. A mass of correspondence had passed between the Tush agents and all sorts and conditions of people organising new ventures. Many of the schemes suggested were, of course, absurd; many more may have been sound enough, but they were not of the sort required; that is, they were not the gigantic undertakings worthy of the notice of such a magnate. Sifted down, there were some ten or a dozen concerns worth consideration.

There was Singman's World Emporium Syndicate for the conversion of his already large business in Islington into a colossal City establishment.

Then Lord Henry FitzEdmund, that shaky old outcast of the aristocracy, had got together a small syndicate of nobodies with high-sounding names, in the hope of building a large new Theatre, a Palace of Varieties, such as would dwarf all the old-established places of entertainment.

The European Hotel Company, under the management of the well-known M. Jean Rideau, wished to open a grand new hotel in some central situation.

There was the good old Lord Whittingbourne, with his proposal for housing the poor; not suggestive of much money-making, but a huge scheme which would cause millions to pass. Besides all these were a new tramway company, a great building syndicate, and many more projects which need not be recounted.

It was difficult, indeed, to see how it was possible for Tush to set them all going. Most of them required capital, and he had none. But, then, his name might secure others who *had;* anyhow, they were all big things, and something might be got out of them. Tush always avoided involving himself by talking matters over too minutely, but preferred (having heard or read all details of the scheme) to leave matters in such a vague, uncertain state, that no one quite understood how much or how little he had become identified with the project.

He was now to meet the various promoters. The best way to do this, he decided, was to ask them each to dinner "to talk it over." If they came and did themselves well, they would return thinking all *was* well, even though nothing whatever had been definitely settled. So all the principals were invited to a great banquet (called a "quiet dinner") at the Savile Hotel, where the millionaire had now taken up his quarters. How all this was to be paid for Tush alone knew, but it was not difficult for a man with such a name and fame to get together a few thousand pounds. Accordingly, one day, the butterfly burst forth from the chrysalis, and even mine host of the Savile, accustomed as he was to wealthy and particular customers, was aghast at the sumptuousness of living displayed. Wherever he went Tush was most lavish with his money. Cabmen were always paid (before strangers) in gold. Waiters received handsome gratuities. Beggars had sovereigns flung to them. Everything was done to display his wealth. The visitors that called had always to be supplied with the best champagne and choicest cigars. The finest suite of rooms in the hotel had to be reserved, three or four servants were specially told off solely to wait on the great man.

Then came the dinner. Each item was of the choicest and the costliest. No money was to be spared in serving the most magnificent repast that could be procured. A large private dining-room was engaged for the occasion. Superb table decorations were tastily arranged on the groaning board. Menus, engraved on solid silver in the form of a suitable souvenir, were supplied for each guest to take away with him. It almost got to the stage of the proverbial city feasts, where a bank-note was placed under every plate (though, in reality, *these* would not have been so easy to supply, credit for such not being so readily obtainable).

The guests duly arrived and were ushered into the presence of their munificent host. A few well-chosen words greeted each of the patrons of progress, and shortly the distinguished company trooped into the great dining-room, resplendent with its dazzling display of sumptuousness and wealth. So the brilliant banquet commenced, Lord Whittingbourne, on Tush's right hand, eagerly discussed his philanthropic scheme, which, as he pointed out, required more capital than he had originally estimated for, since he had come to the conclusion that a good *central* site for the building was most essential, as the working man ought, without doubt, to be near his work. On the other side the Chairman of the European Hotel Company quizzingly referred to the dinner that *he* would give in return when their great London Hostelry should be opened, while Lord Henry, with a satanic grin, wished his grand palace of entertainment was ready for them all to repair to as a fitting *finale* to the programme. The various schemes were each privately referred to during the course of the evening, but little was promised. "Well, we must see what we can do," was the usual vague yet encouraging reply of Cornelius.

The party finally broke up in the best of spirits. Each of the guests considered that *he*, and he alone, had the ear of the all-powerful Tush, looking upon the others as mere guests with no special object to achieve. They all rolled off in their hansoms, cigar in mouth, to instil hope into their respective *confrères* awaiting them at their clubs.

Thus passed off one of the most notable dinners of the day. Ostensibly full of promise of great things, yet, in reality, it might have been barren of results had not the mind of Tush happened to hit upon that great idea which proved so far-reaching in its development.

CHAPTER IV.

The Great Idea.

Cornelius, with heavily-burdened mind, strolled out alone on to the Embankment. Revolving over in his mind the various proposals, he noted that there was one peculiar feature which happened to be common to nearly all of them, which was that they had as their main requirement a large plot of land centrally situated in London. This was all very well, but the place was altogether too crowded as it was. Cornelius was sad, sad because he was baffled. Yet he felt confidence in himself. Past experience told him that expedients and remedies always came eventually to his ever-ready brain; so he lived in hope. He sauntered on along the broad Embankment with its plane trees and dolphin lamps. Many a miserable creature did he pass, skulking along or huddled on a seat. These people did not possess such confidence as his. It is true they found bread was wanting, and lived in hopes of its coming spontaneously to their mouths, rather than that ideas should come to their minds. They thought of present wants, Cornelius only looked to the future. With prospects of impending happiness and plenty we can easily struggle through troubles and hard times, but when there are no prospects, what is one to do? "Turn your mind over," mused Cornelius, "plough it up like a cornfield, put in the seeds, the ideas, the data, and a crop will surely grow." Well, what were the seeds to be? What was required? If only an acre of City land could drop down from heaven and plant itself in its proper place, then all would be well, that is, *if* Cornelius owned it. He wandered on towards that great beacon shining in the sky; that outward and visible sign of the inward and spiritual brain of the Empire, the Clock Tower at Westminster. Here he met the busy, hurrying stream of transpontines making their way homeward, and, carried as it were by the stream, he, too, moved on to the great wide bridge. Possibly because his mind was absorbed, his instinct was leading him to his late home. At the centre of the bridge he stopped and paused to gaze upon the sight presented looking down the river towards the City. The thousands of lights of all colours! The gas lamps, the blue electric lights, the red and green railway lamps, the lurid glow of the illuminated streets beyond, and then their reflections in the great black, surging stream below. How weird that looked! How many people at the lowest depths of despair had there gazed and then thrown their vile bodies into the muddy swirl to end for ever their earthly miseries! Cornelius thought of this. Had he, too, come to that pass? Should he, too, find his death in the gloomy depths, or could he there find the first shooting blade for his mental cornfield? "Ah!" he thought as he surveyed that silent, vast expanse of emptiness devoid of people or traffic, surrounded by crowded houses, yet itself nothing but expanse, a layer of waters stretching so far away to the distant lights lining the south bank, "If that were only dry land!"

The seed has sprouted! The merest speck of green, but there was a speck, and might that not become a blade? "Only *land!*" Could it not be utilised as such? Could it not be *made* land? Here he was standing on solid enough ground with the water flowing beneath him. Could it not *all* be bridged over and houses built on the bridge, even as they were in the days of ancient London Bridge? The river would then be but a huge sewer. What size of pipes would it require to carry that great flow of water? But then, might not the pipes be distributed about under the great City; or could not an enormous tunnel be constructed, deep down, below the level of the "twopenny tubes"? Really, there seemed promise in all this. The Thames, caged and tamed, and made to go where man may will! Then why not divert its course, lead it out into the country, and leave all that great area of City property dry, and available for building? Cornelius fairly gasped. It was a huge idea that had struck his brain. An idea that must be at once carefully fostered and matured.

For some time he remained leaning on the parapet deeply engrossed in his thoughts, oblivious to the human stream that flowed steadily past him. Then suddenly he stood up and looked around. "Yes," he said, almost audibly, "it will be the biggest thing ever heard of. My fortune is made." Then, after eyeing carefully first one end, then the other of the bridge, he briskly walked back, and having aligned himself with the Embankment wall, started to carefully pace the length of the bridge. "Over 300 yards! Then every fifteen yards of river will give us nearly an acre of ground. Why, there must be fully 300 acres between this and the Tower! Here is a site for Singman's Emporium, for FitzEdmund's Theatre, and for all the others put together. I can take on the whole lot, come what may. I'll write to them *all* to-morrow, and say I can arrange for suitable sites *if* they will pay the price and not require immediate possession."

But what was to be the price? It would require a big calculation. Undoubtedly the most practicable scheme was that of deviating the course of the river to flow through country fields instead of among crowded houses. There would then be a huge canal to construct. But though, perhaps, wider, it need not be one-tenth the length of the Suez Canal, and, probably, not so deep, unless, indeed, it were found desirable to make a *ship* canal right round London. The land over which the deviation must be cut would have to be bought. This would require a large sum, since it would involve the purchase of much house property. And whereabouts was it to be? Which would be the best course for the new river to flow to the sea? Where was the lowest lying country, or what would be the size of cuttings through the hills?

Then what was to be done with the reclaimed land, which would be wide enough for, perhaps, four parallel streets? The bed of the river could be filled in, to some extent at least, with the earth got from the cuttings.

There is, too, the river traffic to be considered. All those barges and steamers must go somewhere, else enormous compensation would be demanded. But they don't take up all the river, and a narrow portion could be left as a canal for the water-borne trade of London, while communication between the upper and lower reaches of the river could be continued on the deviation.

Railways, drains, electric wires, and such like could be laid along the bed of the river and built over.

Yes, all this would truly require enormous funds, still it had its merits, and a good thing can always be run if it is properly worked. The capital is there, somewhere. It only needs to be got hold of.

Evidently the way to set about it is to form a huge company. Advertise enough, make the most of all the various advantages to be gained, and all the different ways in which money is to be made out of it (and mention none of the difficulties or possibilities of failure), and the capital will be forthcoming.

Thus did Cornelius conceive his crop sprouting up, and visions of the harvest he would some day reap haunted him throughout the night.

(To be continued.)

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CONTENTS.—See Page VII.

The Great Gnomon at Florence.

By W. ALFRED PARR.

OF the crowds of worshippers who, on Midsummer Day, yearly assemble beneath the vast dome of the Cathedral at Florence to commemorate the festival of San Giovanni, the patron-saint of their city, but

Fig. 1.—The Cathedral (Sta. Maria del Fiore) at Florence, from the south; showing the window in the lantern to which the Gnomon is attached.

few probably give a thought to the astronomical significance of the day they are celebrating. Yet Brunelleschi's wonderful dome—over 138 feet in diameter, and, with its lantern, 387 feet high*—which marked an epoch in architecture, and was the first great triumph of the Renaissance, forms, with its famous gnomon, placed there by the Florentine cosmographer Paolo Toscanelli about the middle of the 15th century, undoubtedly the most stupendous astronomical instrument for determining the summer solstice that the world possesses. So, at least, thought the great Lalande in 1765, when he wrote: "La méridienne que l'on voit dans la Cathédrale de Florence est le plus grand monument d'Astronomie qu'il y ait au monde." But that was some 30 years before his countrymen gave to the world, as an earnest of the eventful expedition culminating in the Battle of the Pyramids, that memorable work, the "Description de l'Egypte," which has formed the starting-point for our present day knowledge of the design and orientation of many of the great temples on the banks of the Nile. Compared with some of these, the Florence "Duomo," considered as a solstitial instrument, must take a very subordinate position in regard to the length of the beam of light utilised.

The temple of Amen-Ra, at Karnak, for instance, was, according to Sir Norman Lockyer, oriented to the summer solstice in such a way that the setting sun flashed a beam of light along its huge axis, something like 500 yards in length, into the sanctuary at the extreme end, heralding to the priests the commencement of a new solar year, and affording them, at the same time, an obvious means of impressing the multitude with a "Manifestation of Ra." At Florence, it is true, Toscanelli's solar apparatus plays no part in the structural scheme of the grand cathedral in which it is placed, although the idea of utilising the ample proportions of a vast public edifice in the interests of astronomy is the same. At Florence, moreover, "the sun had from the South to bring solstitial summer's heat," and thus mark his greatest northern *declination* from the equator instead of being required, as in the sun-god's temple, to register his greatest northern *amplitude* along the western horizon. The method here adopted is, indeed, the venerable one of the *gnomon*; and, having regard to the fact that the Florentine contrivance is higher than the similar apparatus in the churches of S. Petronio, at Bologna (which, by the way, was constructed in 1653 by the first Cassini, the discoverer of the chief division in Saturn's Ring), S. Maria degli Angeli, at Rome, and St. Sulpice, at Paris, put together, Lalande's claim for it may not be so far from the truth as regards this particular form of solstitial instrument.

Situated at a height of nearly 300 feet above the floor of the Cathedral, and firmly built into the marble sill of the southern window in the lantern surmounting the dome, Paolo Toscanelli's famous gnomon must certainly have constituted, together with its solstitial marble let into the pavement far beneath, a very efficient instrument of precision in the days that preceded

* The corresponding dimensions of the dome of St. Paul's are 112 feet and 364 feet respectively.

the introduction of the transit-circle.* This is evidenced by the fact that its illustrious author, who probably constructed it in 1468, shortly after the completion of the Cathedral, obtained by its means a very accurate value for the obliquity of the ecliptic as then existing; his result of 23° 30′ being a more exact figure than the 23° 28′ found by Purbach and his brilliant pupil Regiomontanus. Whether, however, the gnomon was erected by Toscanelli with a view to determining the *variation* in obliquity, as maintained by Leonardo Ximenes and others, is a question to which Celoria† considers no positive answer can now safely be given. The supposition in itself would involve nothing unreasonable, for this gradual variation in the obliquity of the ecliptic, which the modern examination of ancient monuments

Fig. 2.—The Gnomon at the base of the south window in the lantern. The orifice, being protected by a brass cover, does not show in the photograph.

as well as other researches, lead us to conclude was suspected even among some of the ancients, was certainly known in Toscanelli's day, and it is, therefore, improbable that this remarkable man, who was the author of the map used by Columbus on the voyage which resulted in the discovery of America, should not have borne this matter in mind when constructing his great gnomon.

Nevertheless, the mean annual diminution in obliquity being something like 0″.468, the chief factor—time—in so delicate an investigation as this would necessarily be, carried out with the means then obtainable, would be all but absent. Here, again, the Egyptian sun-god might assert his superior claim to be heard in matters astronomical, for the great temple of Amen-Ra having stood for over 50 centuries, its solstitial orientation now shows a deviation of something like one degree; whereas with the Florence Duomo, which can only boast an existence of a little over four centuries, the observed variation, being comparatively small, would be a matter of considerable difficulty to accurately determine, even supposing the gnomon never to have been displaced from its position, which, as we shall presently see, is unfortunately not the case.

The task which Toscanelli had primarily set himself, however, was undoubtedly the correction of the Alphonsine Tables, which were then in operation, but which gave a very inadequate representation of the true solar motion, more especially as regards the exact length of the tropical year. To correct this error, he knew that it would be necessary to institute regular observations of the sun's motion, and it is for this reason, in all probability, that he undertook the construction of the gnomon. This elaborate care to determine the exact moment of the summer solstice in the Florence Cathedral is not without its significance in view of the annual illumination of the dome on Midsummer Night, or the feast of St. John the Baptist; and the *St. John's fires*, kindled in former times in celebration of the summer solstice, now find their analogue in the display of fireworks, which, to the modern Florentine, forms the chief attraction to the festivities annually observed in honour of his patron-saint, San Giovanni.

As it is, many valuable facts relating to the history of the gnomon have unfortunately been lost, for the original inscription on the marble disc marking the solstitial point, which Toscanelli caused to be let into the pavement of the north transept of the Cathedral, was all but obliterated even in the time of Leonardo Ximenes, whose curious description,* published at Florence in 1757, still forms the classic work on this subject. Surrounding Toscanelli's solstitial disc, and placed eccentrically to it, is a larger circle of a different kind of marble, on which is inscribed the date MDX PRIDIE ID IVNII (12th June, 1510), the day on which the summer solstice fell in that year, owing to the displacement of nine days produced by the Julian Calendar which was then in force, the Gregorian Reform not being introduced until over 70 years later.† This larger circle is thought to be the work either of a nephew of Toscanelli, or, more probably, of a certain Antonio Dulciati (who is said to have written on the reform of the Calendar), and is intended to mark the position of the round patch of light which the sun's rays, passing through the circular orifice of the gnomon in the lantern, formed on the floor of the Cathedral at the time of the summer solstice.

As a matter of fact, both the large and the small circle lie somewhat to the west of the true meridian, thus anticipating the exact time of mid-day by about a minute and a half, and it was partly this error which induced Leonardo Ximenes to draw the meridian line which extends for over 30 feet along the pavement. Ximenes, indeed, who was the founder of the Ximenian Observatory in Florence—the institution which still retains the curatorship of the gnomon—not only made important researches in its history, but himself instituted a series of very careful experiments with this huge sundial. Besides tracing a true meridian, and causing

* Introduced about 1600 by the Danish astronomer, Olaus Römer, who first measured the velocity of light.

† *Sulle osservazioni, etc., fatte da Paolo Dal Pozzo Toscanelli.* Rome, 1894.

* *Del vecchio e nuovo Gnomone fiorentino.* (It is interesting to note that Florio in his quaint Italian-English Dictionary, *A Worlde of Wordes*, defines the Italian *gnomone* as "the *know-man* or *gnowman* of a diall, the shadow whereof pointeth out the howers.")

† Viz., in 1582. The Reform was not adopted in England until 1752

both this and the solstitial marbles of his predecessors to be covered with a protecting brass,* he at first re-adjusted and then replaced Toscanelli's gnomon by a new one of the same dimensions in every respect; his

Fig. 3.—The meridian-line and solstitial discs on the pavement of the north transept.

avowed object in bestowing so much care and thought on the apparatus being to bequeath to posterity a means of detecting the slow changes in the obliquity of the ecliptic—the *exiguae eclipticae variationes*, as he very aptly terms them in the long Latin inscription which is affixed to one of the four massive piers sustaining the dome.

But Ximenes' grand design of handing on to future generations an amended edition of this stupendous instrument of research was soon to be frustrated, for even *his* careful corrections were not suffered to remain undisturbed. During some repairs to the lantern his gnomon was removed, and deposited for several years in an adjoining museum; and, although subsequently restored to its position, it was not brought into proper adjustment until 1893, when Padre Giovannozzi,† the present Director of the Ximenian Observatory, again went over the entire work with the greatest precision. Certainly a gnomon subject to fewer vicissitudes might have been obtained had it been possible to carry out the project, once entertained but dismissed as dangerous, of perforating the great dome itself.

Graver difficulties, however, than those occasioned by the hand of the restorer conspire to render this great solstitial instrument now of small value other than an historic one. The fact that only for a little over two months at the time of the summer solstice, can the gnomon be used at all, on account of the normally lower altitude of the sun causing its rays to strike the arches of the dome, would not necessarily impair its scientific value; but the beam of light itself, transmitted through the $1\frac{1}{2}$-inch aperture of the bronze gnomon, is far too seriously affected by atmospheric perturbations, caused by the varying temperature along its extended path from lantern to pavement, to throw more than a very unsteady image on to the meridian below, while that image also, being over four feet in diameter, is of little practical utility from an astronomical point of view; moreover, the expansion due to the sun's heat on the vast building itself would render minute accuracy out of the question.

On the few occasions on which the solstitial observation has been made in recent years, the object has been mainly to detect any slight movement which might have taken place in the fabric of the great Cathedral; and when after the severe earthquake shock of 1895 it was found that the trifling errors in position noted may well have been due to the errors in observation inseparable from this mode of investigation, anxiety for the safety of Brunelleschi's wonderful dome gave place to admiration for the work of its architect. To enhance the effect, it is usual, when carrying out the experiment, to provide the lantern with a temporary flooring, allowing only the beam of light from the orifice in the gnomon to pass down on to the pavement below, while the transept containing the meridian is also darkened, in order to show the disc of sunlight with greater precision.

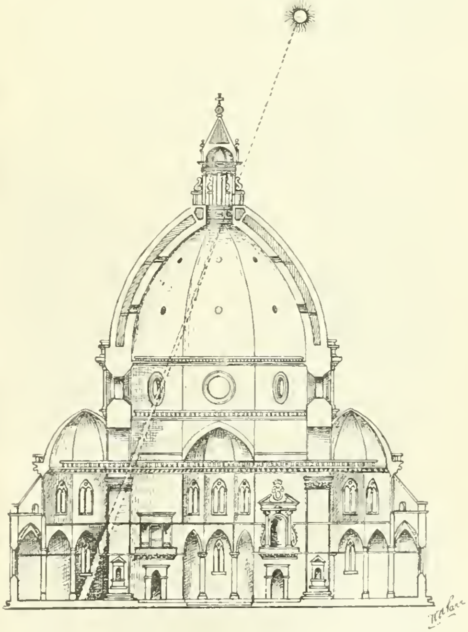


Fig. 4.—Section of the dome, showing the path of the sun's rays at the summer solstice. (After Ximenes.)

* This had not been raised for some years, but at my request Signor Pratellesi, the secretary of the Cathedral Office of Works, most kindly had it removed on the occasion of the summer solstice on June 21st last.

† To whom, as well as to the Vice-director, Padre Alfani, I am indebted for much historical information.

Grand, impressive as is the spectacle of the long beam of sunlight falling athwart the darkened Cathedral, it is, nevertheless, only too true that the "pageantry of Nature" has no place in the science of to-day, and such investigations as the designers of the gnomon had in mind are now conducted with greater accuracy, if with less magnificence, at the transit-circle of every properly equipped observatory. We now know that the gradual change in the tilt of our planet's axis to the plane of its path round the sun, or the ecliptic, which the Florence gnomon was to register for successive ages, occupies a cycle extending through many thousand years, and it has been calculated that this tilt was at a maximum about 7200 B.C., or 9105 years ago, when the inclination of the equator to the ecliptic, or "obliquity of the ecliptic," amounted to 24° 13′. The obliquity is at the present time* 23° 27′ and will reach its minimum of about 22° 30′ some 9600 years hence; a short enough period reckoned from the standpoint of astronomy, but sufficiently long to outlast man's grandest monuments—his most "gorgeous palaces and solemn temples," be the latter dedicated to Amen-Ra, as at Thebes, or to St. Maria del Fiore, as at Florence.

A Sliding Pinnacle.

THE photographs show two views of a slice of a hill which is gradually leaving the mainland and toppling over at the same time. It is to be found near the village of Hebden (near Grassington), in Yorkshire, and, according to the Postmaster there, it must be moving somewhat rapidly towards the valley, for not many years ago it was a favourite walk of the villagers on Sunday evenings to climb the hill and jump across the narrow chasm which at that time separated it from the mainland. Such a feat is, of course, impossible at the present time.

No. 1 shows the appearance of the mass of falling rock as one approaches from Hebden. The rocky remains of some former catastrophe rather prevent one from obtaining a complete idea of the size and inclination of the slice, though the jointed and unequally-weathered nature of the strata is well seen.

No. 1.

No. 2.

No. 2 shows the appearance from the top of the moor looking down towards Hebden, and gives a better idea of the immense size and dangerously overhanging state of the slice.

The surface rock is a hard gritstone, and the slipping may be attributed to unequal weathering of the sandstone layers.

* The exact value for June last [illegible]

DR. H. A. D. JOWETT, who for nearly ten years has filled the position of Senior Research Chemist on the staff of Dr. F. B. Power, Director of the Wellcome Chemical Research Laboratories, is about to leave that position in consequence of his appointment as chief of the Experimental Department at the works of Messrs. Burroughs, Wellcome & Co., Dartford, Kent.

MESSRS. PASTORELLI & RAPKIN, Ltd., have sent us a copy of their illustrated list of Meteorological Instruments, which they have just issued. It comprises all forms of apparatus for observation in this science, both of the standard as well as the self-recording and registered patterns, and should be in the hands of both professional and amateur observers.

The Red Spot and South Tropical Spot on Jupiter.

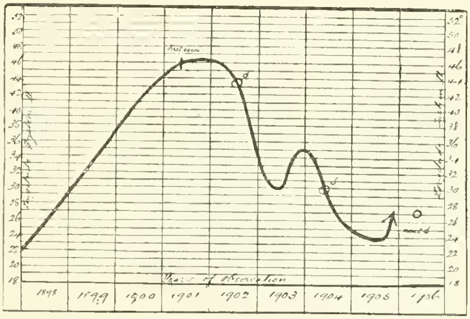
The red spot has exhibited a very fluctuating rate of motion during the past five years. In 1877 the rotation period of this marking was 9h. 55m. 33·4s., and it showed an uninterrupted, though slightly variable, slackening of speed until 1900, when its period conformed with that adopted for System II. of Marth-Crommelin's Ephemeris, viz., 9h. 55m. 40·63s. Since 1900, however, the rate has oscillated between 9h. 55m. 38s. and 9h. 55m. 42s. In the present year, as in 1900, the object has been running nearly level with the rate of System II., and its longitude has not differed materially from 26° since August, 1904. The following are some observations selected from a large number of transits obtained at Bristol in recent years.

Year.	Date.	Transit Time.	Longitude of Spot.	Telescope and Power.
		H. M.	°	
1898	June 7	9 20	25 9	10 in. Reflector, 312
1899	Feb. 2	18 39	29·5	,, ,, ,,
,,	Sept. 14	3 59	34·7	,, ,, ,,
,,	Dec. 30	17 54	35·7	,, ,, ,,
1900	Feb. 20	20 59	37·4	,, ,, ,,
,,	Sept. 3	7 10	44·4	4 in. Refractor, 240
1901	Feb. 13	17 37	43·5	,, ,, ,,
,,	May 28	13 35	45·9	10 in. Reflector, 312
,,	Sept. 29	5 54	43·6	,, ,, ,,
1902	May 20	14 23	44 7	,, ,, ,,
,,	Dec. 31	5 13½	36·3	,, ,, ,,
1903	May 26	16 18	29 5	,, ,, ,,
1904	Feb. 2	4 52½	36·0	,, ,, ,,
,,	Oct. 29	8 9	26·4	4 in. Refractor, 150
1905	Feb. 2	7 36	25·4	,, ,, ,,
,,	Mar. 27	6 43	24 6	,, ,, ,,
,,	June 24	15 43	25 1	10 in. Reflector, 215
,,	July 16	13 57	24 0	,, ,, ,,
,,	,, 30	15 32	23·8	12½ in. ,, 315
,,	Aug. 1	17 9	22 8	,, ,, ,,
,,	,, 18	16 14	23·1	,, ,, ,,
,,	Sept. 13	17 41	22·7	,, ,, ,,
,,	Oct. 6	11 43	23 8	,, ,, ,,
,,	,, 15	14 11	26·5	,, ,, ,,
,,	,, 17	15 47	25·3	,, ,, ,,
,,	,, 22	14 55	25 8	,, ,, ,,
,,	,, 24	16 37	28·2	,, ,, ,,
,,	Nov. 3	14 52	28·8	,, ,, ,,
,,	,, 6	12 20	28·1	,, ,, ,,
,,	,, 7	8 9	26 8	,, ,, ,,

During the period under review the variable motion of this marking has originated differences in longitude amounting to about 23°. Marked accelerations occurred in 1902 and 1904, while the motion was retarded in the last half of 1903, and during the present autumn another decided slackening appears to be in evidence.

To what cause these irregularities have been due appears somewhat doubtful, but it has been conjectured that a large dusky marking, first seen in the spring of 1901, in about the same latitude (south tropical zone), and moving at a more rapid rate than the red spot, has been the means of quickening the speed of the latter. This south tropical disturbance has a rotation period of nearly 9h. 55m. 19s., and, as it overtakes and passes the red spot, may well exercise some accelerating influence upon it. There is indeed strong evidence to support this conclusion, but more observations are required. The two markings were in conjunction in 1902 (July) and 1904 (June), and the phenomenon will be repeated in 1906 (May) if the rate of motion of the red spot remains approximately the same as during the past twelve months. Taking the mean rotation period of the latter marking in recent years as 9h. 55m. 40s., and that of the south tropical spot as 9h. 55m. 19s., there is a difference of 21 seconds in their times, and this indicates that conjunctions must occur at intervals of about 700 days.

Between the present time and next April (Jupiter will be very near the sun in May and June, 1906) it will be important to secure a large number of accurately observed transits of the red spot for the purpose of determining whether there is any decided increase in its velocity. The south tropical spot is now some 110° east of it (about 3 hours following) and the distance is rapidly closing up. If, therefore, this south tropical disturbance is responsible for the longitudinal displacements of the red spot, the



Variations in motion of the Red Spot during last eight years.

The diagram exhibits the variable motion in longitude of the red spot in and since the year 1898. The conjunctions of this marking with the south tropical spot are also indicated. An inspection of the diagram will show that the motion of the red spot appears to have been accelerated at the time the south tropical spot was first seen, and that both before and after the conjunctions of 1902 and 1904 great accelerations occurred.

fact will shortly become apparent in a marked increase of the normal rate of the latter, and we shall find its longitude becoming less.

In recent months the S. tropical spot has presented a remarkable development, and its length has been augmented from 43°·5 to about 60°. My observations of the p. and f. ends of this object during the past four months have been as under:—

Date, 1905.		Longitude, P. end.	Longitude, F. end.	Length.
		°		°
August 7	..	157·9	201·4	43 5
Sept. 13	..	140 3	189·9	49·6
Oct. 19	..	113·3	171 9	58·6
,, 31	..	113 1	170 5	57·4
Nov. 2	..	108·4	165·8	57·4
,, 7	..	109 6	167·0	57·4
,, 11	..	108·5	170 7	62·2

The increase of length between August 7 and October 19 was 15°, which corresponds to a real distension of about 11,000 miles. This enlargement must have occurred

chiefly at the following side of the spot, which has drifted far East relatively to the rotation of 9h. 55m. 19s., representing the normal rate.

While writing I may note that the present autumn has furnished many excellent observing nights. Between October 7 and 14 the weather was very cloudy, but between October 15 and November 11 there were 22 nights clear and 6 overcast. On quite a large proportion of the clear nights planetary definition was found very sharp. This was especially the case on November 6, when I tried powers of 713, 912, 1210, and 1540 on my 12½ in. reflector. The details could be well seen on Jupiter with the latter power; but the difficulty of getting the image into the field, and keeping it there, rendered the use of lower powers much preferable.

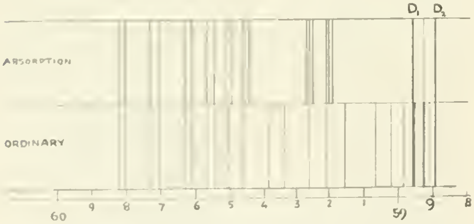
W. F. DENNING.

Bristol, *November* 13, 1905.

Note on the Absorption Lines of Water Vapour.

ON comparatively rare occasions the spectrum of sunlight exhibits very pronounced absorption lines due to the atmosphere being very highly charged with water. These rainbands are particularly prominent in that portion of the spectrum which contains light of wave-lengths between .000059 and .000060 centimeters, *i.e.*, in the region extending towards the red from D about one quarter of the way to α

When the positions of these bands are well known they may be detected as faint lines when the air is less heavily laden with moisture, but if the moisture is excessive they form, after the sodium lines, the most prominent features of the spectrum in the region indicated. In London such occasions of excessive



absorption occurred on June 17, 1902, June 6, 7, and 9, and September 6, 1905, and they were taken to fix the position of the prominent bands as indicated in the drawing.

At 59.20 and 59.26 occur two bands, each of them triplets; at 59.45 occurs another triplet, followed by five doublets, the last of which is at 59.82. The atmospheric conditions being favourable the best time for the exhibition of these bands is in the early morning in summer, picking up light from a low point in the East. However, in June of this year there was no difficulty in obtaining them at any hour and at any altitude on the 6th and 7th day of that month.

Unsettled weather always accompanies these strongly-marked bands, and their existence certainly forms a very trustworthy warning of a bad day.

T. H. B.

The Zodiacal Light.

By ARTHUR MEE.

MR. MAUNDER has well shown in his "Astronomy without a Telescope," that an object which requires no instrument to study, which most people can see if they try, and which has been observed for countless generations, still remains to a great extent a mystery. The object is the Zodiacal Light, that nebulous cone which appears in the west after sunset in early spring, and in the east before sunrise in late autumn, and which, bright in the tropics, may still be profitably studied in our less favoured latitudes by anyone whose horizon is not troubled by the glare of artificial light.

Kepler, long ago, came to the conclusion that the Zodiacal Light was an appendage of the sun, and his opinion has on the whole, received the confirmation of modern observers; but much more remains to be done before all the necessary data have been secured, data which in no way depend on the telescope, but must be collected by naked-eye observers, aided by the virtues of accuracy and patience

It is not our purpose here to deal with the methods of observing and studying the light. These are dealt with fully in the charming work above referred to. But we desire to call attention to some very interesting observations just made by Dr. Simon Newcomb, the eminent American astronomer, which indicate, so far as they go, that the Zodiacal Light lies to the north and south of the sun as well as to the east and west of our great luminary. Prior to Dr. Newcomb's observations no attempt has ever been made with success to observe the Zodiacal Light to the north of the sun; in fact, the feat is one presenting a good deal of difficulty.

To begin with it cannot be done when the sun is less than 18° below the horizon, on account of the interference of twilight, nor must 18° be exceeded to any great extent else there would not be enough of the light left above the horizon to be seen. In fact (as Newcomb points out), unless the minor semi-axis of the light considerably exceeds 18° it may be for ever impossible to distinguish it from twilight itself. The observation may best be made in latitudes such as our own, but there must in addition be a perfectly clear horizon, and the more elevated the post of observation the better. Dr. Newcomb tells us that even in the clear air of the United States he has so far failed, a fact which, in itself, indicates that the observation is a most delicate one, demanding not only a trained eye, but the most perfect of local conditions.

Whilst in Europe this summer the distinguished astronomer determined to try his experiment amongst the mountains of Switzerland. He therefore consulted a Swiss scientist, who advised the Brienzer Rothorn, a summit suitably situated, easily accessible, and nearly 8,000 feet high. Thither Dr. Newcomb repaired on July 26, and made careful observations on that evening and also on the 29th.

At 10 o'clock on the first of the evenings in question the twilight had completely passed, but there was a faint glow over the north-western horizon which, twenty minutes later, was 20° west of north. It afterwards became well marked, and was watched until the haze thickened and put an end to observation.

At midnight of the 29th the glow was again seen, and Dr. Newcomb made the following note :—

"12 h. 5 m. to 12 h. 10 m. Local M.T. The characteristic Zodiacal glow distinct and unmistakable—not so bright as ordinarily seen east or west of the sun, yet several grades brighter than the limit of doubt. It extends from a little east of Capella to a region below the pointers. The maximum of brightness is midway between Capella and the north point, say between 10° and 150° east azimuth and at 10° of altitude. The appearance of maximum brightness below Capella was evidently due to the Milky Way."

Dr. Newcomb (who also glimpsed the Gegenschein) believes he has established the fact that in the direction of the sun's axis the Zodiacal Light is brilliant enough to be plainly seen to a distance of about 35° on either side of the sun, and he suggests "that the Zodiacal Light be hereafter described as a luminosity surrounding the sun on all sides, of which the boundary is nowhere less than 35° from the sun, and which is greatly elongated in the direction of the ecliptic."

The Aurora of November 15th.

By W. Shackleton.

A fine display of the Aurora Borealis was witnessed in London on the evening of November 15. I first noticed the phenomena at 9.10 p.m., when the sky about 15° W. of N. appeared illuminated by a crimson glow, with occasional crimson streamers, shooting up towards the zenith. The crimson appearance, however, did not last very long, and by about 9.30 p.m. had entirely disappeared. I was not able to commence spectroscopic observations until the crimson had disappeared, and then I could not trace any red line, but over a considerable area in the sky the green aurora line was very strong, together with two fainter lines more refrangible and apparently a continuous spectrum in the blue violet; the region of spectrum less refrangible than the principal green line appeared a perfect blank. Prof. Fowler informs me that he commenced observation shortly after 9.20 p.m., and was able to trace the green line until 11 p.m.; he also states that on the same morning he observed a brilliant metallic prominence eruption on the W. limb of the sun, and, in addition, there was considerable activity in the large group of spots, in the western hemisphere, as indicated by the reversals and displacements of the bright lines, more especially C. (Hα.)

Royal Geographical Society Meetings.

December 4.—Exploration in the Abai Basin, Abyssinia. By H. Weld Blundell.
December 18.—Exploration in New Guinea (*with Cinematograph Illustrations*). By C. G. Seligman.

Other provisional arrangements are as follows :

Unexplored India. By Colonel Sir T. H. Holdich, K.C.M.G., K.C.I.E., C.B.
The Economic Geography of Australia. By Prof. J. W. Gregory, F.R.S.
Survey and Exploration in Seistan. By Colonel A. H. McMahon, C.S.I., C.I.E.
Exploration in Tierra del Fuego. By Captain Richard Crawshay.
Exploration in the East Tibet Borderlands. By Lieut. Filchner.
Explorations in Bolivia and Peru. By Baron Erland Nordenskjöld.
The Philippine Islands. By Prof. Alleyne Ireland,
Northern Rhodesia. By L. A. Wallace.
The Geographical Influences of Water Plants in Chile. By G. F. Scott Elliot.
Maps of London. By Laurence Gomme.

The Coloration in Mammals and Birds.

By J. Lewis Bonhote, M.A., F.L.S., F.Z.S., M.B.O.U., etc.

Although the literature on colour and coloration in the animal kingdom has reached huge dimensions, and the subject is one which has occupied zoologists from the earliest days, yet we are still a long way from a complete understanding of the causes and use of colour. And since any series of facts carefully collected, or a suggestion, however slight, may prove a stepping-stone towards a more complete knowledge of what are undoubtedly the most conspicuous features among animals, I feel that no further excuse is necessary for a paper of whose deficiencies no one is more conscious than the writer.

On the one hand chemists and physiologists have restricted their investigations to the extraction and analysis of pigments, and on the other hand the majority of zoologists have studied coloration from the standpoint of its utility to the organism in its environment. Few, however, have considered the fact that colour has probably its *primary* cause and utility in satisfying some physiological need of the animal, while natural selection has come in secondarily and eliminated the unsuitable, or perfected those colours and markings that were able to be adapted for purposes of protection, warning, &c.

It is not my purpose here to enter into a long discussion, pointing out special cases where natural selection seems to have failed, or where its advocates seem to have overstepped the limits of probability. This has already been done by many writers, and although they may have partially succeeded in showing that natural selection is not sufficient to account for the *cause* of coloration, yet their work has been, in the main, destructive rather than constructive, and it is probably owing to this tendency that the physiological aspect of colour is not more widely accepted to-day.

I do not, therefore, propose in this paper to deal in any way with natural selection, but, rather, to bring to light further evidence in support of the contention that colour is primarily due to the vigour of an animal, so that where we find conditions suitable to a high state of vigour we shall there find a corresponding increase in the colour.

Secondly, I shall try to show that many of the markings and longitudinal stripes on an animal will be found to have their origin in certain spots, which I propose to call "poecilomeres," and I shall attempt to bring forward considerable evidence to show that these "poecilomeres" arise from physiological causes.

Those who have kept and studied live animals know that the state of the coat or plumage is an unfailing criterion of health or sickness, and that without any moult a bird, on recovering from an illness, becomes much brighter and more glossy, and I know of a case in which the black plumage of a bird became quite brown during sickness, and re-gained, to a limited extent, its black and glossy appearance with the return of health.

We may, therefore, take it for granted that when an animal's health becomes in any way affected, the change

will be visible externally in the animal's coat or plumage.

Before going further it would be well to define exactly what I mean by *vigour*.

I prefer to employ a term which has already been used in a somewhat similar sense by Wallace and other naturalists, rather than coin a new one*.

By *vigour* is meant what one would popularly describe as "high fettle" or "condition." An athlete trained for a race is full of "vigour" so far as his muscles are concerned.

Physiologically speaking, however, I mean by "high vigour" that an animal's whole body is in that state of physiological activity which would enable it to stand severe strains and exertions without being adversely affected.

"Activity of nutrition and function" (the phrase is borrowed from Dr. A. E. Durham, in Quain's Medical Dictionary) is the best definition of what I mean by "vigour."

So that:—

The colour of an animal will be primarily dependent on its "activity of nutrition and function" being at a high or low level.

An animal's "vigour" is affected by several causes.

1st. *CLIMATE.* A heading which may be again sub-divided into

(*a*) Temperature.

(*b*.) Food supply.

2nd. *The rise and fall of sexual activity.*

In those animals whose vigour is not constant throughout the year, the changes will take place in correlation with one or other of these causes.

The effects of the first we may call *seasonal change* in contradistinction to the second or *breeding change.*

I now propose to consider the mammals and birds according to the regions (Polar, Tropical, or Temperate), in which they live.

I. THE POLAR REGIONS.

In the Polar regions the period of extreme cold and scarcity of food is so long as compared with the short, bright summer, and the transition from the one to the other so abrupt that the inhabitants thereof will be subject to violent changes.

The winter follows so quickly after the breeding season that there is no time, as in more temperate regions, for the animal to recuperate after the lowering effects of sexual activity. Such reserve material as is formed will, therefore, be stored up in the form of fat, a condition in which it is most accessible for any subsequent demands that may be made upon it by the body. This storing up of fat, as Captain Barrett-Hamilton has shown†, is one of the concomitants of sluggish metabolism. Here, therefore, we have conditions of low vigour, and in correlation with them we find the animal for the most part white or grey.

In the spring we would expect that the excitability of the breeding season, as well as the higher temperature and more plentiful food, would tend to a high state of vigour, but it must be remembered that the privations of the winter have so lowered the animal's condition, that it is unable to derive full advantage from the more favourable circumstances, and its vigour is, therefore, unable to reach a high level. In correlation with this we find a predominance of duller colours amongst the majority of Polar animals.

How, then, are we to account for the darker animals of these regions, as, for instance, the musk ox, penguins, and raven?

If our suggestion holds good, the fact of these animals being dark coloured in these regions proves that they are able to maintain their full vigour throughout the year, in spite of the cold and scarcity of food.* Now if this be so, we ought to find these animals throughout the world equally highly coloured or more so, or it is conceivable that if their "vigour" is so great in cold localities, it might become too great in warmer regions, and being unable to find any outlet for this excess (the animal being already highly coloured), death might ensue†, and such animals would, in consequence, be restricted to the colder portions of the world. The raven is a good example of the first of these conditions, for the Corvidæ exist practically unchanged throughout the world, and the musk ox and lemming fulfil the second. The mouse hares (*Ochotona*), although Alpine rather than Arctic, give us a good idea of seasonal change, and show us that the amount of "vigour," rather than the climate, may affect their colour.

For example, two species—*O. ladacensis* and *O. roylei*—inhabit adjacent countries where climatic conditions are very similar. *Ladacensis* is white, or nearly so in winter, and light brown in summer, whereas *roylei*, which becomes bright red in summer, never becomes paler than iron grey in winter.

So that here we have two nearly-allied species inhabiting the same country, each equally influenced by the climate so as to cause them to undergo a seasonal change, yet in winter one is white and the other—in defiance of the laws of protection—dark. Captain Barrett-Hamilton has also brought to my notice another similar instance in the case of the Siberian lemmings (*Dichrostonyx* and *Lemmus*), where the light or protectively-coloured species is much scarcer than its more conspicuous relative.

The penguins, again, are birds whose nature is such as to enable their "vigour" to reach its fullest extent in Antarctic regions at all times of the year. It is not surprising, therefore, to find several specimens, *e.g.*, the emperor penguin, indulging in patches of bright colours, such as yellow, orange, or red, thus affording a further proof that "vigour" rather than "climate" is the prime factor in determining the coloration.

To carry our point further, we should expect to find the vigorous, dark Arctic species breeding earlier than those that are paler coloured, and in confirmation of this we find the raven breeding very early in April, while the ptarmigan and grouse wait till the latter end of May.

The lemming is another instance, for it is a brightly-coloured animal, and in certain seasons produces young more numerously and rapidly than any other Arctic animal, while as a result of this excessive "vigour," we find it most pugnacious and energetic.

(To be continued.)

*The following writers may be said to have written on the subject from this standpoint, viz.: Bateson, Barrett-Hamilton, Beddard, Cunningham, Geddes and Thompson, Newbigin, Tylor and Wallace.

† *Proc. [illegible]* Vol. [illegible] Sect. B., Pt. [illegible], P. 307 (1903).

* It might be argued against this that in these cases, the colour having been placed in the hair, it could not be withdrawn, and not being harmful, but even, perhaps, useful (as has been suggested for the musk ox), the animal was enabled to survive. If these animals only moulted in spring, such an argument might hold good; but in the case of the raven, the moult is in autumn, and I fancy the same holds good for the penguins.

† The excessive energy of white men on first coming to the tropics is a frequent cause of their overtaxing their powers, so frequently culminating in drink or fever.

Seismoscopes.

By Charles Davison, Sc.D., F.G.S.

Instruments designed for the registration of earthquakes may be divided into three classes: (1) those which give the time of occurrence only; (2) those which record and magnify the actual movement of the ground without any determination of time or duration, and (3) those which register the time, amplitude and period of every vibration, so that the actual movement of the ground may be completely realised. Those belonging to the first class are usually known as *seismoscopes*, and those of the second and third classes as *seismographs*. The latter as a rule are elaborate and costly apparatus, and can only be constructed by skilled workers and with the aid of refined tools. On the other hand, some forms of seismoscopes may be easily and cheaply made, and the errors due to home-manufacture are not of much consequence. They establish, what is an important fact, that a disturbance of some kind has taken place, and, without much trouble, they may be made to record its time of occurrence.

In a paper published in "Knowledge" for August, 1896, a few suggestions were offered for the observation of earthquakes without instrumental aid. The present paper, which may be regarded as a supplement to the other, contains descriptions of a few of the simplest kinds of time-recording seismoscopes.

Every such seismoscope consists of two distinct parts, one for magnifying the movements of the ground, and the other for recording the time. In the latter part, there is some, though not great, variety, seismoscopes, otherwise different, making use of the same kind of recorder. A good clock, or one the error of which is known, is its essential feature. The simplest type of seismoscope is one in which some arrangement is made for stopping a clock, or starting a clock (previously fixed at some known time), at the instant when an earthquake occurs and attains sufficient strength to affect the instrument. In the best form of all, the record is made without stopping or in any way affecting the motion of the clock, and it is obvious that, in a country where earthquakes are at all frequent, this kind should be adopted whenever possible. Even in Great Britain, many records may be lost if the instrument is put out of action by the first tremor of a series. For instance, within seven hours on the night of December 16-17, 1896, at least ten earthquake-shocks were felt in the neighbourhood of Hereford; while, during a still shorter interval in the early morning of September 18, 1901, one observer near Inverness counted no fewer than twenty shocks.

Mallet's Seismoscope.

One of the earliest and simplest seismoscopes adapted for stopping clocks was that devised by the well-known seismologist, Robert Mallet. This is shown in fig. 1, in which A represents the bob of the clock pendulum, B a piece of stout wire passing through the centre of the bob at right angles to the plane in which the pendulum oscillates, and C D a strip of wood, an inch or an inch-and-a-half wide and a quarter-of-an-inch thick, weighted at the end C, and turning freely about a pin driven into the wall or some steady support at the end D. This lath passes through holes in the side of the clock-case, and its lower edge is cut into teeth in that portion which covers the arc of oscillation of the pendulum. E is a log of heavy wood, four to five feet in height and five or six inches square; the lower end, which rests on the ground, is cut off square, and the top is cut down to about a quarter-of-an-inch square, so that the lath C D may rest upon it. When

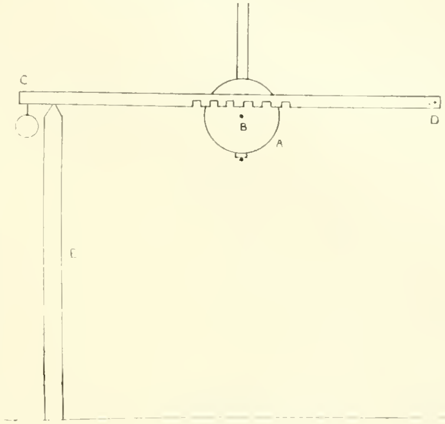


Fig. 1.—Mallet's Seismoscope.

the log E is overthrown by a shock, the lath C D falls, and the teeth, catching the pin B, will stop the clock.* The dimensions of the apparatus may obviously be varied at pleasure; its chief defect lies in the roughness of the starter E.

Milne's Seismoscope.

Professor Milne's seismoscope is free from this defect, in having a more sensitive arrangement for dropping the lath C D. Instead of the column E (fig. 1.), he uses a simple horizontal pendulum E G C (fig. 2.), which is more readily displaced by a weak shock. The lath C D and the pendulum bob are arranged as by Mallet, but the lath ends at C in a piece of wire. E C is a straight wire, passing through a

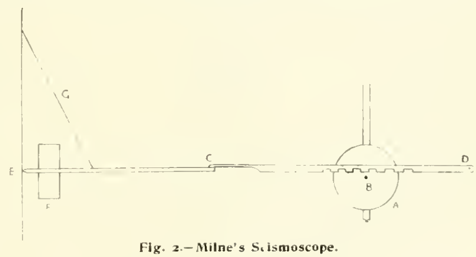


Fig. 2.—Milne's Seismoscope.

disc of lead F. The end E is sharpened and rests in a small conical hole made in the head of a drawing-pin pressed into the side of the clock-case, and the wire E C is supported in a horizontal position by a silk thread G fastened to the clock-case at the upper end by

*In another form of seismoscope suggested by Mallet, two strings pass from the log of wood through the sides of the clock-case, and are fastened to the pin at the lower end of the pendulum. The lengths of the strings are adapted so that, while hanging loose within the clock case, they permit the pendulum to swing freely; but stop it immediatly the log E is thrown down by a shock.

a drawing-pin or nail vertically over the pin at E. A very slight movement of the clock-case displaces the wire E C, and the lath C D falls as before and stops the clock.

Marvin's Seismoscope.

Professor Milne's seismoscope may easily be constructed with home-made appliances. The next two instruments, designed by Professor C. F. Marvin and Dr. G. Agamennone, are of less simple form. Professor Marvin's seismoscope, which is in use in the United States, is illustrated in fig. 3. A heavy weight A is suspended from the frame B by means of a steel

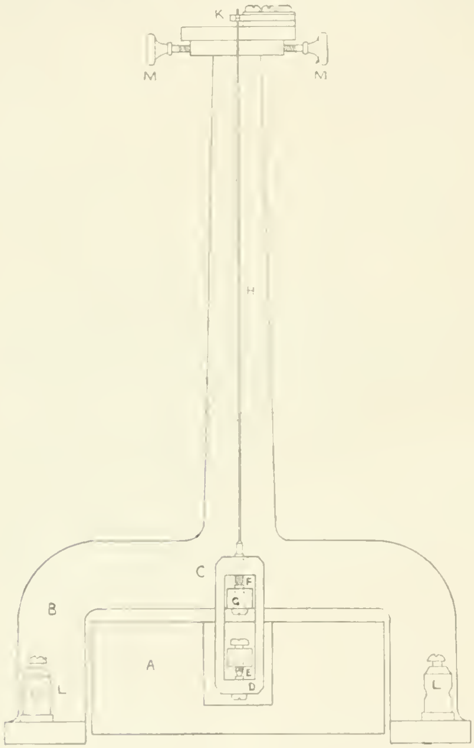


Fig. 3.—Marvin's Seismoscope.

link C, which passes partly through the centre of the weight. At the bottom of the link is a small hole D, into which fits the sharp point of a screw E rigidly connected with the weight, and so adjusted that the point is just above the centre of gravity of the weight. At the top of the link is a similar pointed screw F, resting in a hole made in a projection G from the frame B. When suspended in this manner, the weight A is obviously in stable equilibrium. From the top of the link C there projects upwards a slender and flexible pin H, about six inches long. The upper end of the pin is tipped with platinum and passes through a small hole (also lined with platinum) in the plate K at the top of the instrument. This plate is electrically insulated from the frame B, but is connected by a wire with one of the binding screws L fixed to the base. The position of the plate can be adjusted by means of four screws M (only two of which are shown in the figure) so that, when the seismoscope is in working order, the tip of the pin H is exactly in the centre of the hole in the plate. The binding screws L are connected with the poles of a battery.

When an earthquake occurs, the frame B moves with the ground, but the heavy weight A remains nearly at rest. The movement of the frame with respect to the weight is magnified several times at the upper end of the needle H; and, if the original displacement is great enough, the tip of the needle touches the side of the hole in the plate K, and completes the circuit. By such means, a clock may be stopped, and, if desired, an electric bell may be rung to give notice that the clock requires attention; or a record may be made on a strip of paper moved by clockwork.

The latter method is that which is employed in the United States Weather Bureau, at Washington. The time-recorder there is the so-called "weekly anemometer register." This consists of a horizontal cylinder covered by a sheet of paper and revolving by clockwork once in six hours. A pen rests lightly on the paper as the latter passes underneath. The pen is connected with an electro-magnet fixed to the base of the register, and this again with the seismoscope, and, when the circuit is closed during the occurrence of an earthquake, the pen is slightly displaced to one side, and the record of a shock consists of a notch in an otherwise uniform line. The paper is marked with lines corresponding to intervals of five minutes, but, as the clock which drives the cylinder cannot be depended on for keeping accurate time, the electro-magnet is also connected with a good pendulum clock so adapted that the circuit is closed momentarily once every five minutes. "The record of an earthquake," Professor Marvin remarks, "consists of a succession, more or less prolonged, of lateral jogs or strokes on the line traced by the pen, whereas the clock record consists of a single stroke occurring regularly and of very short duration." The paper is driven at the rate of $2\frac{1}{2}$ inches an hour, and it is thus not difficult to determine the time of a shock to within a quarter or half a minute.

Agamennone's Seismoscope.

At first sight, there is some resemblance between Dr. Agamennone's seismoscope and Professor Marvin's. The principal difference lies in the fact that the perforated plate is itself movable and magnifies the original displacement of the ground. The seismoscope is thus doubly sensitive. It is used chiefly in Italian observatories, but is also to be found in Hungary, Roumania, Bulgaria, India, the Dutch Indies, etc.

The base A of the instrument (fig. 4) is a circular plate of cast iron, standing on three equidistant feet, two of which are levelling screws. Three vertical rods, B, C, and D, rise upwards from three points of the base which form the angular points of an equilateral triangle. The rod B is made of steel, and is about 14 inches long, the lower part, $2\frac{1}{2}$ inches in length, being a thick steel wire, and the upper portion a fine steel rod, $\frac{1}{25}$th of an inch in diameter, and ending at the tip in a short platinum wire. A lens-shaped disc of lead E, weighing a little less than half-a-pound, is fixed by a screw to the rod B near its lower end. The second rod C is of twice the thickness of the other, and of about the same length, and carries at its upper end a similar disc of lead F, fixed to it by a screw. To this disc is attached a small horizontal plate of platinum G, perforated by a small round hole and so adjusted that

Photograph of the Sun, October 22nd, 1905.

the platinum tip of the rod B passes exactly through its centre. Thus, as both the rod B and the hole in the plate G are subject to displacement, and as the rods

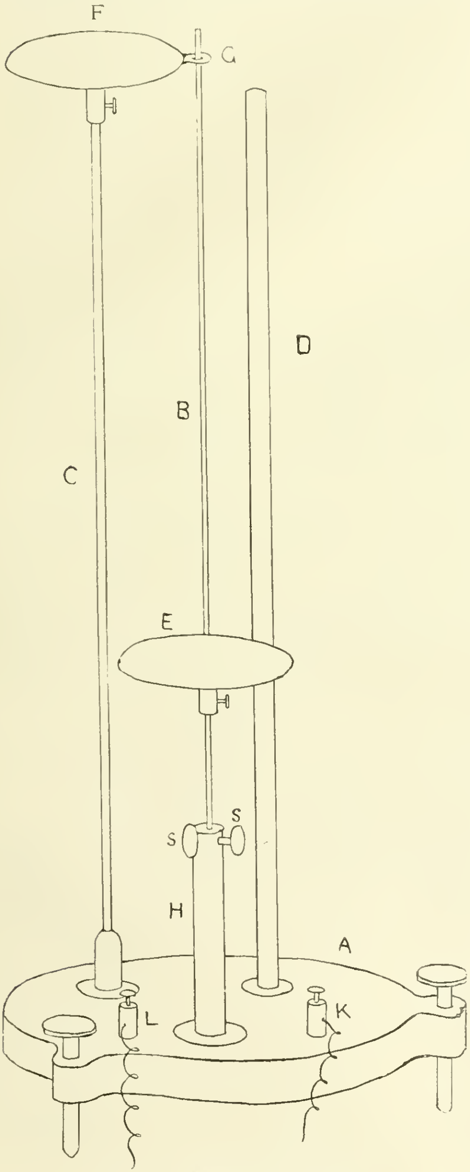


Fig. 4.—Agamennone's Seismoscope.

B and C have different rates of vibration, it is obvious that a very small movement of the ground is sufficient to bring the tip of the rod B into contact with the rim of the hole in the plate G.

This forms the essential part of the apparatus, but several details are required in order to adjust the tip of the rod centrally within the hole. In the earlier forms of the apparatus, the plate G was attached to an arm springing from the rod C, and provided with two screws at right angles to one another for making the necessary adjustment. But, as the rod C vibrates more rapidly than the rod B, it was found advisable to transfer the adjusting apparatus to the latter. The thick steel wire, which forms the lower part of the rod B, is fixed to the bottom of a strong tube of brass H, let into the base A. At the top, this tube ends in a brass ring, in which work two screws S and S, at right angles to one another, which press against the thick steel wire forming the lower portion of the rod B. With this change, the necessary adjustments are made more easily than in the earlier forms of the instrument ; but, to attain this end still more rapidly, the stout rod D is provided, by touching which the oscillations are quickly damped.

The two rods B and C are electrically insulated by discs of ebonite from the base of the apparatus, and are connected with the binding screws K and L, and these again with the binding screws of the seismoscope clock. This is an ordinary clock, the pendulum of which is drawn to one side and held back by a small tooth at one end of a lever. Immediately the platinum tip of the rod B touches the rim of the hole in the plate G, the circuit is completed, an electro-magnet fixed to the base of the clock raises the toothed end of the lever, and the pendulum is thus released. If the clock is previously set at some known time, say twelve, the time indicated by the clock when next observed gives the time that has elapsed since the beginning of the shock. If an electric bell is included in the circuit, attention may be drawn to the fact that the pendulum requires re-setting ; but it would be more satisfactory if the record were made, as in Professor Marvin's seismoscope, on a revolving drum, the rate of which is not interfered with by any but a very strong shock.

On account of the delicacy of Dr. Agamennone's seismoscope, it is necessary to exercise some care in the choice of a site. It should be placed at least in a room on the ground floor, but better still in a cellar at some distance from a frequented street. The most satisfactory foundation would be one of stone sunk in the ground below and entirely disconnected from the cellar floor. It should also be covered by a glass shade, in order to protect it from currents of air or other accidents.

Photograph of the Sun.

October 22nd, 1905.

THE accompanying photograph was taken with an ordinary $4\frac{3}{8}$-inch astronomical refractor telescope. It is enlarged three diameters from the original negative, which was obtained with a power of 40 on the telescope. A yellow isochromatic screen was used, and the exposure $\frac{1}{100}$dth second on a Cadett lantern plate. The photograph shows the large group of spots (which was visible to the naked eye in October) nearing the sun's western limb, and another large spot surrounded by faculæ just coming into sight on the eastern limb. The photograph was taken by Mr. E. W. Barlow, F.R.A.S., of Bournemouth.

The Venom of Spiders.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

SPIDERS have gained an evil and frequently undeserved reputation as venomous enemies of man, and certain species are still regarded by the natives in some parts of Africa with as much horror as poisonous snakes.

We find numerous references in ancient and mediæval writers, *e.g.*, in Aristotle's Natural History, to the deadly effects caused by the bite of spiders, and the facts eventually became so exaggerated and distorted, that many writers in the last century went to the other extreme and ridiculed the idea of any spider producing injurious results in man.

It is only within the last two or three years that the question has been investigated by scientific methods, and that we have been able to form an opinion as to what amount of truth there was in the old conflicting accounts that have come down to us.

Leeuwenhoek appears to have been the first to give an exact description of the poison fangs of the spider, and his account, published in the Transactions of the Royal Society for 1702 (Vol XXII., p. 867), opens in the following quaint terms :—" I have often heard speak of the Sting of a Spider and that with the same he is able to kill a Toad, but having never learned whereabout this Sting grew, I fancied it in the Tail as it happens in most Flying Insects."

He then goes on to describe how a frog bitten by a spider died within an hour, whereas a second frog bitten by another spider was not affected in the slightest degree. In explanation of this, he suggests : " Now 'tis possible that the Stinging of Spiders in hotter Countries may be more pernicious than in our Climate ; 'tis also possible that this Spider might have spent his Poyson lately by wounding another Spider or any other Creature." Professor Kobert's investigations (*infra*), doubtless supply the true explanation of the difference, which was probably that the spiders belonged to different species.

In a later volume of the Transactions (1726), there is a letter from a Dr. Robie in New England, giving an account of the serious illness of a man who had been bitten in the leg by a small, black spider, but was better after 24 hours.

All the early Italian scientific writers contain accounts of cases that had come under their observation. Dr. Silvio Boccone (*Museo di Fisica*, 1697) describes numerous instances where illness had been caused through the bite of the malmignatte in Corsica.

Fontana, writing in 1781 on viper poison, mentions that the bite of a certain kind of spider might be fatal; and Dr. Luigi Toti gives a full description of the symptoms of 17 cases that he had himself attended prior to 1794. Of these 15 recovered after a few days, one was only saved with difficulty, and one died. The effects are described as being exactly similar to those caused by the bite of a viper. He himself was bitten by four of the little malmignattes, which had just been hatched. There was some inflammation in the vicinity of the bites but no general symptoms.

Cauro (1833), confirmed Toti's statement as to the effects of the bite of the malmignatte resembling those produced by viper venom. He stated that the natives of Corsica used a secret remedy, which he found to consist of a mixture of opium and camphor, and to be very effective.

The spider to which all these Italian writers refer is the *Lathrodectes tredecimguttatus*, popularly known as the malmignatte. It is about a third of an inch in size, and is characterised by the red spots on its black body. Another European spider belonging to the same family is the *Lathrodectes conglobatus*, which is found in Greece. It is smaller than the malmignatte and has white spots instead of red. The Russian species (*L. erebus*), known as the kara-kurte (black wolf), is common in South Russia and Turkestan, where it is a great object of dread. It is jet black, and without any spots.

Species of spiders belonging to the same family are also found in America (*L. mactans*), and in Australia (*L. scelio*, " *Katipo*," and *L. Hasseltii*), all of which are reported to produce symptoms similar to those caused by the bite of the European and Asiatic species. Both the Australian species have red spots on a black ground.

According to Vinson (*Aranéides des Iles de la Reunion et Madagascar*, 1863), the natives of Madagascar are in deadly terror of *Lathrodectes menavodi*, which resembles the Italian malmignatte in size and appearance, but have not the slightest fear of an allied black species. This is cited by Dr. Laboulbene (*Dict. des Sciences Médicales*) as a proof of the great exaggeration of the effects of the malmignatte bite, and he attributes the fear of the natives solely to the more ferocious aspect of *L. menavodi*. The answer to this contention is supplied by Dr. Kobert's results.

Walckenau, in 1837, made some of the largest spiders to be found near Paris bite him, and never experienced the slightest ill effects. Similar experiments were made about the same time by Duges in the South of France, but the most serious result was a slight inflammation.

Blackwall, the great authority on British spiders, published the results of his experiments in the *Transactions of the Linnean Society* for 1855 (Vol. XXI., p. 31). He found that no ill effects were produced upon himself by the bite of various spiders, including the garden spider (*Aranea diademata*), and that even insects were not affected by the venom injected by the fangs of the spiders. He asserted that " the serious and sometimes fatal consequences which have been attributed to the bite of the malmignatte must be regarded as amusing fictions in the natural history of the *Araneidea*."

The French naturalist, Dufour (1864), also came to the conclusion that the danger of the bite of the spider was to a large extent imaginary.

The question remained in this state of uncertainty until, in 1901, Dr. Robert Kobert published an excellent monograph dealing with the whole subject. He obtained recent data of cases of bites, and did an immense amount of experimental work with spiders of different species, notably the Russian kara-kurte (*L. erebus*). Detailed reports were sent to him of 22 cases admitted to the hospitals in the Chersonese during 1888. In each instance the bite had felt like a bee sting, and there was usually no swelling around the place, but soon violent pains were felt in the limbs, and this was succeeded by difficulty in breathing and cold perspirations, both the heart and central nervous system usually being affected. Recovery was generally complete after five days.

Dr. Kobert made extracts from the crushed fresh or dried bodies of these spiders, by means of a dilute solution of salt, and thus obtained solutions that were extremely poisonous, producing all the symptoms attributed to the bites.

The poison was not confined to the glands, for ex-

tracts from the legs or the abdomen proved just as venomous as those made from the chephalo-thorax. New-born spiders were more venomous than adults, and the cocoons and eggs more venomous still.

Extracts from the dreaded tarantula were found to be quite innocuous, and this was also the case with all the other families of spiders examined, with the exception of the common garden spider (*Aranea diademata* [*Epeira diadema*]), which yielded extracts producing very similar toxic effects. Both caused paralysis of the respiratory system and heart, accelerated the coagulation of the blood, and had a strong solvent (hæmolytic) action upon the red blood corpuscles.

The fact that all parts of these spiders were poisonous is analogous to what has been observed in the case of snake venom, which is not confined to the poison glands alone, for it has been proved that the blood of poisonous snakes is also venomous.

Dr. Kobert also confirmed Toti's statement that the venom is harmless when swallowed, and this is another point in which it resembles snake venom.

He further succeeded in rendering animals immune against the venom by inoculating them with gradually increasing doses, and their immunised serum conferred protection on other animals.

Both the lathrodectes poison and the poison of the garden spider were destroyed by heating them at a comparatively low temperature, and by the addition of alcohol, but the former was somewhat more stable than the latter.

Dr. Kobert concluded that both were of the nature of "toxalbumins," i.e., substances resembling white of egg in chemical composition, but possessing toxic powers.

Many poisons, however, including snake venom, which were formerly regarded as toxalbumins, have been found when properly purified to be free from albuminous substances, and doubtless this will be found to be also the case with spider venom.

(*To be continued.*)

Consumption of Tobacco.

In the Department of Commerce of the United States some statistics have been drawn up regarding the consumption of tobacco during recent years per head of population in different countries. The following are the results :—

Belgium	2,817	grammes.
United States	2,389	,,
Germany	1,560	,,
Austria	1,370	,,
Canada	1,243	,,
Australia	1,175	,,
Hungary	1,098	,,
France	980	,,
United Kingdom	885	,,
Russia	499	,,
Italy	476	,,

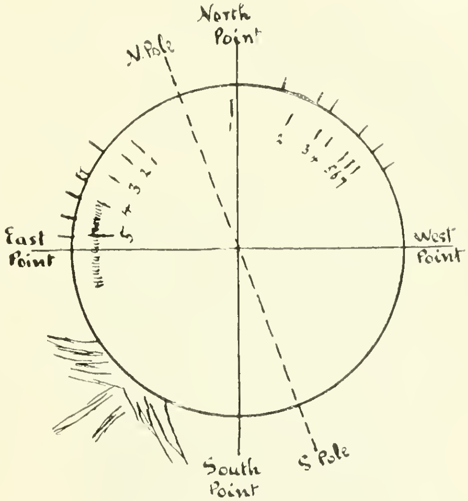
This is almost in the inverse order of the amount of taxation on tobacco.

Royal Institution.—A Christmas Course of Lectures, adapted to a juvenile auditory, will be delivered at the Royal Institution by Professor Herbert Hall Turner, D.Sc., F.R.S., on "Astronomy." The dates of the Lectures are December 28, 30, 1905, January 2, 4, 6, and 9, 1906, at three o'clock.

CORRESPONDENCE.

To the Editors of "Knowledge."

Gentlemen,—In the three accounts of the recent eclipse published in "Knowledge" last month, there are considerable discrepancies as regards the position of the two groups of prominences. It is with extreme reluctance that I venture to differ from so eminent an observer as M. Moye. But my observations, aided by a telescope, were made very carefully, and I saw no prominence, much less a group, in the southern hemisphere. I send a diagram which shows outside the circle twelve prominences marked at the telescope. One is double-stemmed, and one is floating. Within the circle I have marked those shown in Fr. Cortie's six photographs, done at



the same time and place. The agreement is substantially exact. In the N.-E. quadrant, No. 5 was of very great height. Though it appeared the first, it is visible in the last of the photographs, taken at the very end of totality. On both sides of No. 5 there is a long blur of light in the first photograph, like the elevation of that length of the sierra. This was not noticeable in the telescope, probably owing to the very pale tint of the chromosphere and prominences.

My eye-piece was divided by spider threads into quadrants, and the north point approximately fixed by running sunspots along the horizontal wire.

Yours faithfully,
Augustin Morford.

The Friary, Saltash, Cornwall,
November 8, 1905.

[In our article in the October number occurs the sentence, "Photographs alone can give us the true position and dimensions of the prominences," and these eye sketches, valuable as they are in many respects, must give way before the incontrovertible evidence of the photographic plate.—Ed.]

Answers to Correspondents.

Gamma. The white-hot part of a coal fire is at a temperature of over 2500° Fahrenheit, though in an ordinary domestic fire it seldom attains a real white heat. A dull red-heat is about 1200° F.

Rev. M. McLean. This was the aurora borealis, described on p. 293. It is very rarely seen so distinctly in England.

Photography

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Distortion with Focal-Plane Shutters.—It has often been pointed out that an exposure made by passing a slit opening over the face of the sensitive plate must lead to a distorted image of a moving object, because the various strips of the object corresponding to the slit opening are photographed consecutively as the object moves. This is so obviously the case that it is surprising to find the statement met with answers to the effect that if distortion exists it is negligible because it is rarely discernible. Whether or not distortion is visible must depend very largely upon the eye of the person who looks for it, and upon the character of the object distorted. A critically-trained eye can see what ordinary observers never will be able to see, and there are some distortions that cannot be detected unless the object, or an undistorted image of it, is available for comparison. A short, broad person, for example, may be improved in appearance by having his height increased or his breadth diminished by twenty per cent.

Some excellent examples of distortion with focal-plane shutters will be found in the current volume of the "British Journal of Photography" at page 807 *et seq.* Here may be seen motor cars all out of shape, and photographs of a rotating white strip or lath which do not suggest the object photographed at all. At page 858, Mr. C. Welborne Piper gives two photographs of a riding bicyclist. In one the man is slight and the wheel-base of his machine short, in the other the man is stout and the wheel-base long, and the wheels are distorted in both. It must not be concluded from these examples that focal-plane shutters are useless instruments, but rather that they should always be avoided when a shutter at the lens diaphragm, or as near to it as possible, will do the work. It is certainly true that with a focal-plane shutter the lens acts with practically its full aperture all the time, but the advantage of this has been very much over-rated. Many who lay so much stress on it probably never knew the rate of movement or the equivalent exposure given by any of their shutters in any of their exposures. A record of a movement that requires an exposure of less than the two hundredth or three hundredth of a second can often be obtained only by means of a focal-plane shutter. The resulting distorted image may be sufficient record as it stands, or it may be possible to eliminate the distortion by redrawing it, if the constants of the shutter are known.

Is Development a Reversible Reaction?—In the October number of this journal I referred to a paper on this subject by Mr. S. E. Sheppard, published in the Chemical Society's Journal for August, and remarked that in using the word "reversible" the author does not appear to consider the difference between developable and non-developable silver bromide. I said "the silver bromide is reduced by the developer because it is in the developable condition, undevelopable silver bromide not being reduced under the same conditions. When the reaction is reversed, the resulting silver bromide would, I suppose, not be likely to be in the developable state." In answer to this Mr. Sheppard writes as follows.—

"In the October issue of your journal, Mr. Chapman Jones, in referring to a paper of mine on the reversibility of photographic development (*Journ. Chem Soc.*—Sept. 1905) criticises the application of the term 'reversible' to this reaction on the ground that the silver bromide reduced by the developer is in a 'developable' condition, due to the action of light, whilst that reformed by the reverse reaction to development is presumably not so. The phrase 'developable silver bromide' can hardly be said to express any exact conception, since with a reducing agent of sufficient potential silver bromide, either alone or emulsified, can be reduced to silver without any previous exposure. If, however, we take it to mean in this case, reduction by the ordinary developing agents of practice, Mr. Jones' criticism still fails to hold, as the silver bromide reformed by the reverse 'bleaching' action is 'developable' forthwith and without any preliminary exposure to light, a fact in agreement with photographic practice in intensification by redevelopment (*cf.* Messrs. C. W. Piper and D. J. Carnegie, *Amateur Photographer* for June, 1905). The real point at issue is, of course, the nature of the so-called 'latent image' formed by light, but this question, however interesting, cannot be dealt with in a brief letter."

It has long been known that the reaction between ferrous oxalate and silver bromide is reversible. For more than twenty years practical advantage has been taken of this fact in the use of ferric oxalate to thin or dissolve away a part of the silver from a negative that is too dense. It may be objected that no alkaline bromide is added in this case, but that does not affect the essence of the reaction. Mr. Sheppard has determined the conditions of equilibrium, including the effects of alkaline bromide and dilution. In doing this he claims to have "shown experimentally that development is a *reversible* chemical reaction" (quoted from his abstract of his paper in the Proceedings of the Chemical Society).

I cannot see that he has done anything towards proving *development* to be a reversible reaction. Development and simple reduction of the silver salt must be distinguished. A reagent that will reduce silver bromide will not, therefore, develop an image. Silver bromide exists in the developable and the non-developable conditions, although it is reducible to the metal in both conditions. Mr. Sheppard says that "'developable silver bromide' can hardly be said to express any exact conception," but this has nothing to do with the matter. We are dealing not with conceptions but with facts. The difference between developable and non-developable silver bromide is a fact, it is more than the chief corner stone of photography, it is the very foundation of it, and conceptions, exact or otherwise, do not affect it. It is just in this that the difference exists between simple reduction from a chemical point of view and development from a photographic point of view, and so far as I can see Mr. Sheppard has not gone beyond the simple chemistry.

But suppose for a moment that Mr. Sheppard had proved development with ferrous oxalate to be a reversible change, he would not have proved development in general to be reversible, because ferrous oxalate is a developer by itself, and, as a matter of practical fact, is now very rarely used. There are many developers of quite a different character (chemically considered) and, perhaps, different in their action as developers. Probably the most simple of these is hydroquinone (or quinol). Of this Mr. Sheppard himself says "this reverse reaction is largely nullified by the presence of alkali and alkali sulphite, always used with organic developers, as these substances alone or mixed react with the quinone, reducing it to quinol." So there seems to be a difficulty here, even with so simple a substance as hydroquinone, in proving development to be reversible—a difficulty that Mr. Sheppard has not overcome. And even if development with both ferrous oxalate and hydroquinone were proved to be reversible changes, it would not necessarily follow that develop-

ment with other reagents is also reversible, as hydroquinone has marked peculiarities.

Mr. Sheppard's reference to the use of the word "development" by Messrs. C. W. Piper and D. J. Carnegie is beside the mark. This word is in common use and has many applications. We talk of "developing" a carbon print when we merely wash away the soluble gelatine from it with water; we "develop" a platinum print when we bring about a simple chemical reaction; an essay writer "develops" his subject; and an athlete "develops" his muscles. In the "redevelopment" referred to there does not appear to be any distinction between developable and non-developable silver salt—it seems to be rather a simple case of removing the halogen from its silver compound.

A New Tripod.—The limitations of the ordinary tripod are all too well known by those whose work requires the camera to be supported in other than an approximately horizontal position or in places where the ground is steep and irregular. These difficulties are practically overcome in Butler's "Swingcam" camera stand. The wonderful adjustability of this stand is obtained by attaching each leg to the tripod top by means of side links and a swivel block. In replacing a single movement by three separate movements a loss of rigidity might be expected, but the adjusting screws so clamp the whole of the moveable parts together that the maker claims an increase rather than a loss of stability. Further conveniences in connection with the stand are extending bars which will raise its height to over seven feet, and swivel points to the legs, so that the points may be fixed vertically to obviate slipping when the legs are unduly splayed out. These points may even be bent up and converted into hooks, so that, for example, one leg may be secured to a convenient object above the camera, such as the branch of a tree. It is impossible to describe all the ways in which the stand may be used.

The Thornton-Pickard Company send us the list of winners of the £100 Competition for pictures taken with their cameras. The numerous prizes range from £10 to £2.

NOTES.

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

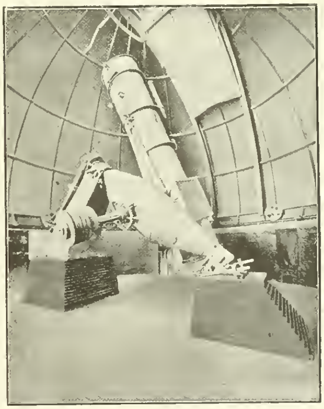
The Newly Mounted Three-Foot Crossley Reflector.

This fine instrument, which was first erected at the Lick Observatory in 1895, has been almost entirely remodelled according to designs of the astronomers there. Although much excellent work was done with it in its original condition, it was found that many details were unsatisfactory for the prosecution of the delicate investigations which the late Director Keeler had proposed to devote its great light-gathering power. From the extremely promising records obtained it was thought that the great value of its excellent parabolic mirror in astronomical photography emphasised the desirability of supplying it with a more rigid and efficient mounting than the one comprised in the original bequest. This was authorised by the Board of Regents in 1902, and after much consideration it was decided to adopt the form shown in the illustration. The heavy parts of the mounting were built by the Fulton Engine Works of Los Angeles, while the driving clock, slow motions, guiding mechanism, and all small parts were constructed in the Lick Observatory repairing shops.

The polar axis is of heavy boiler steel, furnished with steel jackets shrunk on to form the bearing surfaces. The declination axis is a heavy shaft of solid steel passing through the centre of the polar axis. One end carries the tube of the telescope, the other the usual counter-balancing weights.

The tube consists of a cubical central section of castings, with cylindrical sections above and below the cube to carry the eyepiece and large mirror respectively. The upper end section can be rotated for adjustments in position angle. The total weight of the moving parts is about 6 tons, and although somewhat cumbersome has the important advantage that it allows of passing the meridian in all positions without reversal.

As the driving mechanism had to be very delicate, the driving sector was made large, with radius of eight feet, the worm having a pitch of one-tenth of an inch, and as a complete driving wheel of this size would have been too unwieldy, two sectors were provided, so that one could always be ready for gearing up as soon as the other was running out. Each sector will run for 66 minutes.



In connection with the optical arrangements important modifications have been introduced. The ordinary method with Newtonian reflectors of throwing the image out at the side of the tube by a plane mirror placed diagonally has been discarded, and the plate holder fixed in the centre of the tube so that the plate is in the direct optical axis of the large parabolic mirror, and of course it cuts off in this position no more, or probably less, light than did the original diagonal mirror.

The adoption of this system then rendered it necessary to bring the screw adjustments of the plate holder to the side of the tube, and this has been done along one of the thin plates which hold the plate carrier. By means of a small reflecting prism the guiding star at the side of the photographic plate is also viewed by a subsidiary telescope at the side of the tube.

On account of the old difficulties special precautions were taken in designing the mirror cell and supports, and it is very satisfactory to find that Professor Perrine reports that the whole is very satisfactory after several months of use. The focus of the instrument can be determined easily to 0·005 inch, and it does not appear to change greatly with variations of temperature. No change of focus has yet been detected in a range of less than 10° F. Evidence of the great efficiency of the instrument is afforded by the splendid success achieved by Professor Perrine in his recent important discoveries of the VI. and VII. satellites of Jupiter in the earlier part of the present year.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Coffees without Caffeine.

THE alkaloid caffeine, to which tea and coffee owe their stimulating property, crystallises in glistening white needles, which melt at a relatively high temperature, and can be sublimed unchanged. Tea contains some 3 or 4 per cent. of this alkaloid, and coffee about 1½ per cent., while it is also present in maté, or Paraguay tea, and guarana, a beverage prepared by the natives of Brazil from the seeds of *Paullinia sorbilis*. M. G. Bertrand discovered four years ago that a species of coffee, *Coffea humblotiana*, growing in Madagascar, was quite free from caffeine, although containing a bitter principle to which he gave the name *cafamarine*. Since then he has found several other species of the coffee plant to contain only a small proportion of caffeine, and quite recently has examined three new species which were absolutely free from the alkaloid, but contained a bitter substance analogous to that occurring in *C. humblotiana*. All of these coffee plants devoid of caffeine grow either in Madagascar or the neighbouring islands, and are not found on the African continent. In order to determine whether the soil or climate had any immediate influence upon the development of caffeine, experiments were made with the ordinary coffee plant, *C. arabica*, but the plants grown in Madagascar invariably yielded the normal proportion of alkaloid.

The Cultivation of Plants on Radio-Active Soil.

Some extremely interesting experiments have been made by M. A. v. Poehl to determine the effect of cultivating pharmaceutical plants at Tsarkoie-Selo, near St. Petersburg, where the soil contains argillaceous schists, which, as is well known, are radio-active. The plants were examined after a year, and were found to contain radium, which, however, was only present in the roots and stalks, and never in the flowers.

The Utilisation of Natural Gas.

Natural gas is found in constant association with petroleum, but has hitherto been put to but little use, at all events in Europe. In Boryslaw, for instance, it is particularly plentiful, but is for the most part allowed to escape into the air, with the exception of the small quantity used for heating the vessels in which the crude petroleum is distilled. In America, however, it is used as the source of a gas black for printing ink, for the illumination of houses, to which it is supplied under a pressure of half an atmosphere, and as fuel for glass-works and other factories which have been built near the sources of supply. In this country the natural gas discovered at Heathfield, in Sussex, is collected and used for lighting the houses. The possibility of many new applications of natural gas is suggested by the fact that Herr Wolski has taken out a patent in Austria for its liquefaction, and that the process has been found a success in the Carpathian oil fields. The liquefied gas begins to distil at about 106° C., and the first fraction consists in the main of the hydrocarbon methane. The vapour tension of the liquid is relatively very small, and the product can therefore be safely kept or transported in ordinary soda water syphons. It seems likely to have a great future before it for such purposes as lighting isolated houses and driving small gas-engines and motors, whilst being a bye-product of the petroleum industry its cost will be much less than that of ordinary coal gas.

A New Ferment.

There are many species of yeast, but until recently none was known that was capable of resisting a high temperature. Messrs. Johnson and Hare, however, have separated from eucalyptus leaves a new species possessing this characteristic in a high degree, being able to convert sugar into alcohol at a temperature of over 105° F., which would be fatal to ordinary yeasts. At the end of the fermentation the new yeast, to which has been given the name of *Saccharomyces thermantitonum*, falls to the bottom of the vessel in a compact agglutinated mass. The cells are more oval and rather smaller than those of the more common saccharomyces, and have several other distinguishing features. The use of this ferment has been protected by 55 patents in different parts of the world, for its great commercial value is due to the fact that by its means fermentations can be carried on in tropical countries, where hitherto this was out of the question. A further advantage is that it is possible by simply heating the cultivations to destroy foreign micro-organisms without injuring the yeast. It is so resistant to heat that it can withstand for a short time a temperature of 170° F. Even after the cells have been killed by being submerged in water at 176° F., the active agent or enzyme they contain is still capable of producing a weak fermentation.

Sympathetic Inks.

Sympathetic inks are commonly regarded as chemical toys, although the fact that several recent patents for such inks have been taken out shows that they have practical uses of commercial value. One of the earliest means of writing in characters that were nearly invisible until warmed was milk, the use of which was recommended by Ovid, whilst Pliny makes mention of various plants whose juices were suitable for the same purpose. Numerous references to secret inks occur in mediæval writings, but we can only make a guess as to their composition. Brossonius, writing in a medical treatise in the earlier part of the 17th century, describes a "magnetic fluid," prepared from "arseniated liver of sulphur," only visible when looked at "with the eyes of affection." This appears to have been nothing more than a solution of lead acetate, the characters being rendered visible by the action of sulphuretted hydrogen. This lead acetate ink is described by several other early writers, and notably by Otto Tachen (1669), who points out that there is nothing magnetic or miraculous in its action. It was described as "sympathetic ink" by Le Mort, and the name was afterwards extended to all preparations suitable for secret writing. The curious behaviour of salts of cobalt when heated was first described by Waiz in 1715, and solutions of one or other of these have since formed the basis of many of the so-called sympathetic inks. Cobalt chloride, for instance, is pink in the crystalline condition, but when heated loses water and becomes blue. Characters written with a solution of this salt are nearly invisible on white paper, but turn blue with heat, and then gradually absorb moisture from the air becoming pink again, and practically disappearing. In the case of some other substances a re-agent is required to develop the writing. Thus characters written with gall extract turn black on treatment with an iron salt; gold chloride gives purple writing with tin chloride, and starch gives a blue coloration with iodine. The last-named ink has long been a favourite with sharpers of the racecourse, two of whom were last year convicted of the fraud. A betting paper giving the names of the horses is written in two kinds of ink, one of which speedily fades away, while the other gradually appears. The disappearing ink is often a weak solution of iodine tinged with starch, and the characters written with this soon fade. For the invisible writing a favourite ink is a solution of silver nitrate, which darkens under the influence of light. An ingenious application of a sympathetic ink, patented by Kromer, insures the detection of any tampering with an envelope. The dry constituents of the ink, *e.g.*, tannin and iron sulphate, are separated by means of the adhesive gum, so that should steam be used to open the envelope they come into contact and leave a stain upon the paper. A sympathetic method might be based upon the fluorescence of quinine salts under ultra-violet light, or of other compounds when exposed to the rays of radium, &c.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

"Wash-Outs" in Coal-Seams.

THE subject of "wash-outs" occurring in some of the middle coal-measures of South Yorkshire has been dealt with by Mr. F. E. Middleton, F.G.S., in a paper recently published in the Quarterly Journal of the Geological Society. He is of opinion that they occupy the sites of winding streams, which meandered through the alluvial tracts in which the coal-seams were being formed. This would account for breaks in the continuity of the deposition of certain seams, but true wash-outs

would be those which were attributable to subsequent denudation of seams as originally formed. In the Eureka seam in Netherseal Colliery (South Derbyshire Coalfield) the wash-out, instead of being one broad hollow, consisted of numerous confluent streams, and these united together to form a main channel, like the head-waters of a drainage system. Mr. Middleton points out that in the Barnsley seam denudation has been found over an area 1700 yards in length from east to west, and in the Parkgate seam (240 yards below) over an area 2600 yards long from north to south. Although the wash-out in neither case was completely crossed, the width, it is thought, could not be less than 600 yards.

The Genus Glossopteris.

The question of the true affinities of the genus *Glossopteris* at present remains an open one. As a rule, it is classed with the Filicales, but this classification can only be regarded as a convenience, and must not be regarded as finite. Minute organs, elliptical in shape, have been in close association with *Glossopteris Browniana*, in specimens from New South Wales, which Mr. E. A. N. Arber, F.G.S., F.L.S., thinks are not unlike the sporangia of certain recent and extinct ferns and cycads. There is, however, no trustworthy evidence as to their contents. That they may be attributed to this genus is indicated by the fact that they have never been found except in the closest association with the scale-leaves of *Glossopteris*, whilst some of the scale-fronds show scars of attachment and fragments of sac-like bodies still apparently in continuity. A close analogy may perhaps be found, Mr. Arber thinks, in the micro-sporangia of cycads.

Tertiary Limestone at Belmont Hill.

In reference to the white tertiary limestone from Herne Hill, to which I recently referred, my attention has been called to some hard flinty "race" which was found this year at the base of the *cyrena* Shell-bed (Woolwich series), about 12 feet from the surface, at Belmont Hill, Blackheath. This has been analyzed by Mr. H. Dixon Hewitt, for the Geologists' Association, with the following result:—

Calcium carbonate ($CaCO_3$)	94·7
Magnesium carbonate ($MgCO_3$)	0·7
Iron and Aluminium Oxides ($Al_2O_3 + Fe_2O_3$)	3·0
Sand and Clay	0·6
Combined Water, traces of Alkalis, Phosphates, &c. (by difference)	1·0
	100·0

Submerged Coast-Lines.

At the opening meeting of the Geological Society of London on November 17, an important paper on "The Coast-Ledges in the S.W. of Cape Colony" was read by Prof. E. H. L. Schwartz. Similar coast shelves have there been found to those which characterise both the European and American sides of the North Atlantic. The most striking of these remarkable coast-shelves is said to be the Upland Shelf, extending from Caledon to Port Elizabeth. It is cut by deep gorges into narrow ridges or "ruggens," but at a height the level tops of these ridges can be observed. The surface is in places covered with superficial deposits, cemented boulder-deposits, gravels, and sandy clays, hardened at the surface into ironstone or freshwater quartzite. Prof. Schwartz considers that this shelf cannot have been formed as a peneplain, but by marine denudation. On the 150 to 200 feet plateau there are deposits with marine shells, and in a depression on its top the evaporation of rain-water produces a large quantity of salt. The rock-shelf under the Cape Flats appears also to have been cut by the sea. The Agulhas Bank seems to consist of a succession of ledges, but it is not known whether further shelves extend beyond its margin. Taking the ledges together, the continent would appear to have been subject to lifts of 600 or 700 feet, with intermediate halts and setbacks.

What is the Thirpole?

We all know Cuvier's *Palæotherium*, or "ancient wild beast" of the Paris basin, but what are we to understand by the name "Thirpole," to which Dr. W. Martin, of Lincoln's Inn, refers in the following communication? It will be seen that he suggests that the two names are of identical origin. He says: "What is the fish called *Thirpole* that is alluded to in the following quotation from Staunford's 'Exposition of the Kinge's Prerogative' (edition 1577)? 'So in Bracton's time it was doubted by the common lawe, whether the King should have this great fish called *Thirpole* wholly or not. And so likewise in Britton's time, as it may appear in his book fo. 27, which now this statute hath made clear and without question.' I cannot find any reference to this fish either in Bracton, in Britton, nor in the statute to which allusion is made. Possibly *Thirpole* was a word newly coined by Staunford from the Greek words θηρ, a monster, and παλαιός, ancient, venerable, and was meant to be equivalent to 'that leviathan,' about which so much was heard, but which was never seen. I may mention that whales, sturgeons, and possibly porpoises, were considered, when caught within seas that were part of the realm, the property of the sovereign or his consort, and were consequently called 'Royal Fish.'"

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

The Duration of Life Among Birds.

When we consider the great numbers of those who are interested in birds, it is strange that there should have been so little recorded as to the age to which birds live.

Parrots are proverbially long-lived, and most of us are familiar with the story of the venerable bird which Humboldt met with in South America. Though voluble enough none could understand it, as it spoke the language of a tribe of Indians—Atures—which had long become extinct.

Weissman mentions a white-headed vulture which died in the Zoological Gardens at Vienna in 1824 after 118 years of captivity. Ravens are said to have lived 100 years in confinement, while canaries and linnets may live from 10 to 18 years.

The latest contribution to this subject will be found in an extremely interesting article by Lady Ingram in the *Windsor Magazine* for November. Herein will be found many curious and not a few really valuable facts, especially with regard to the question at issue. Thus white birds are generally supposed to be less robust than more normally coloured, yet a white sparrow whose life history is described in this article has lived 13 years in confinement, and during this time has reared no fewer than 12 broods! Though this bird is still in good health it appears, however, to be showing signs of age.

Hoopoe in Inverness-shire.

The *Field*, November 11, records the fact that a hoopoe was shot at Onich, Inverness-shire, during the first week in November. It had, unfortunately, been hovering about the neighbourhood for some days, and had been kept under observation by one or two well-wishers, only to fall a victim at last.

Breeding of Common Kite in Wales.

Owing to the action of the British Ornithologists Club, aided by the kindly co-operation of Earl Cawdor and Dr. Salter, the last remnant of the kites in Wales were this year enabled to rear their young unmolested; two pairs succeeding in bringing off two young each. It is believed that no young kites have been reared in Wales for at least 10 years past.

Breeding of the Bower-Bird in Confinement.

Mr. Reginald Phillipps is to be congratulated in that the Regent bower-birds (*Sericulus melinus*) in his aviaries have this year succeeded in rearing young. Two birds were hatched, the first on August 6, the other two days later; by August 22 both birds had left the nest, having, it is to be noted, well-developed wings, but scantily covered bodies. Unfortunately one of these birds was killed during September, apparently by swallowing the shoots of an elder tree; but the other bird is now full grown and hardly distinguishable from the female. The period of incubation appears to be nineteen or twenty days. This is the first record, we believe, of the breeding of these birds in confinement.

A New British Shrike.

At the meeting of the British Ornithologists Club held on October 18, Mr. M. J. Nicoll exhibited a fine male adult specimen of *Lanius nubicus*, which had been killed at Woodchurch, Kent, on July 11, 1905.

Black eared Chat in Sussex.

At the meeting of the Ornithologists Club just referred to, Mr. M. Nicoll also exhibited a black-eared chat (*Saxicola stapazina*), which had been killed at Pett, in Sussex, on September 9. This bird, Mr. Nicoll pointed out, belonged to the Eastern form of the species, having the underside of the wing and the axillaries jet black. The two previous occurrences of the black-eared chat in these islands were both of the Western form (*Saxicola catarinæ*).

Aquatic Warbler in Sussex.

Mr. Nicoll also exhibited at this meeting an aquatic warbler (*Acrocephalus aquaticus*) which he had shot at Rye, Sussex, on August 15 of this year, and reported that during the day he saw about half-a-dozen of these birds in one large reed-bed.

Aquatic Warbler in Hampshire.

Mr. H. F. Witherby exhibited at the meeting of the Club just referred to, an aquatic warbler which had been taken on St. Catherine's Lighthouse, Isle of Wight, on September 29 last. The bird was an immature female, and made the third record of this species in the county.

Icterine Warbler in Hampshire.

Mr. Witherby exhibited, with the aquatic warbler, an immature female of the icterine warbler (*Hypolais icterina*). This bird had also been taken on St. Catherine's Lighthouse at the same time as the aquatic warbler, and was the first recorded instance of the occurrence of this species in the county of Hampshire.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Emission of Corpuscles in the Dark.

It is well known that the alkali metals give out negative corpuscles (i.e., electrons) when exposed to light, even when this is of very feeble intensity. Thus in the case of sodium or potassium or their liquid alloy, Elster and Geitel found that a negative charge was dissipated by the light from a petroleum lamp; while from the still more electro-positive metal rubidium negative electricity could be discharged by the light from a glass rod just heated to redness. The order of the metals for this effect is the same as the order in Volta's series for contact electricity.

Professor J. J. Thomson has now shown that, with the metals mentioned, there is a small emission of corpuscles, even when all external light is excluded. An electroscope is placed in a bulb, which can be very highly exhausted by means of charcoal cooled to a very low temperature—the brilliant device of Sir James Dewar for very rapidly producing exceedingly high vacua. Clean rubidium or K-Na alloy is placed below the gold leaves, and the metal is earthed. The whole is placed in a light tight case, no light being admitted except a momentary illumination through a red glass window for the purpose of reading the deflection of the leaves. Even this momentary illumination produced a slight leak, which can, however, be separated from the true leak by the fact that the latter is proportional to the interval between the readings, whereas the former is independent of this interval.

When the leaves of the electroscope were charged with *positive* electrification, there was always, even in the dark, a small leak of electricity, while there was no leak when the leaves were *negatively* charged. The leak apparent in the former case is attributed to negative corpuscles leaving the alkaline metal and settling on the leaves. This is proved by the fact that when the bulb is placed in a transverse magnetic field the leak stops.

The presence of a minute quantity of hydrogen in the bulb has an extraordinary influence in increasing the leak; in some cases after the admission of the hydrogen, it was made ten times as great. This increase rapidly died away, but was renewed on admitting a fresh supply of hydrogen. No increase was produced on admitting carbon dioxide.

Final Disintegration Product of Radium.

Rutherford considers that the ultimate residue after all the charged particles have been emitted by radium is lead. The atomic weight of radium is 225; five Alpha particles at least are known to be expelled during the successive changes that take place. If each of these is an atom of helium of mass 4 the residue must have an atomic weight of 205, which is exceedingly close to the atomic weight of lead. In support of this conjecture, he cites the fact that in all radio-active minerals lead is present, and its amount is roughly proportional to the helium present. This would be the case if both of them are disintegration products.

ZOOLOGICAL.

By R. Lydekker.

Some Fossil Reptiles.

Since our last column of Notes was written three papers of more than usual interest have appeared on extinct reptiles. In the first of these Mr. C. W. Gilmore has published a brief illustrated account of the complete skeleton of that most marvellous of all fossil reptiles, the great horned dinosaur (*Triceratops prorsus*) of the Cretaceous strata of Wyoming. In addition to its horns, the most extraordinary feature about this creature is the huge size of its head, with its great frill-like collar extending backwards well on to the shoulders. This is shown by the fact that while the length of the entire skeleton is 19 feet 8 inches, that of the head is no less than 6 feet, or nearly one-third the total dimension. In this respect *Triceratops* presents a strange contrast to the *Diplodocus* skeleton in the British Museum, in which the head is only about one-eightieth of the total length. Nevertheless, the horned monster was no better off in the matter of brains than its small-headed cousin.

In the second of the two memoirs Mr. L. Dollo, of the Brussels Museum, gives us the results of his investigations on the footprints of the iguanodon, based on specimens from the Wealden strata of Hastings and its neighbourhood. From a careful study of these tracks the author is enabled to tell us the approximate postures assumed by this giant dinosaur when running, walking, and at rest.

In the third and last paper Mr. Gilmore confirms the discovery that the so-called toothless American fish-lizard, *Baptanodon*, really possessed a few rudimentary teeth, thus bringing it into close relationship with *Opthalmosaurus* of the English Oolites.

The Deafness of Fishes.

Despite the fact that carp in a pond will come up to be fed at the sound of a bell, a learned German professor has arrived at the conclusion that fishes of all kinds are in all probability stone-deaf. This conclusion, startling as it may seem, is largely based on the fact that these creatures lack a certain structure in their auditory organs which the professor regards as absolutely essential to the function of hearing. Such vibrations in water as fishes are capable of perceiving are consequently believed to be transmitted by a sense compatible with our own sense of touch or feeling.

South America, Africa, and Australia.

In his recent presidential address to the Zoological Section of the British Association Mr. G. A. Boulenger, from the evidence of freshwater fishes, is disinclined to believe in a land-connection during late geological times between South America and Africa. Professor W. B. Scott, from the study of certain fossil mammals, is, on the other hand, convinced that such a connection did exist; while the examination of some supposed fossil marsupials from Patagonia leads Mr. W. J. Sinclair (who, like Prof. Scott, belongs to Princeton University) to be equally confident as to the existence of a similar

bridge between South America and Australia. With such diversity of views among "doctors" it is a little difficult for the amateur to know which lead to follow; and it is therefore satisfactory that the subject is not one involving any vital or pressing issues.

Ancestry of the Dog.

From deposits in Russia belonging to the polished stone-age Dr. T. Studer has recently described the skeleton of a large kind of dog closely allied to the domesticated species. This dog, which it is proposed to call *Canis pontiatini*, is believed to have been originally wild but subsequently domesticated by early man. In general characters it comes very close to the Australian dingo. By crossing between this species and the wolf Dr. Studer believes that other extinct species or races of dogs have arisen, and from these in turn have been developed the mastiffs on the one hand and the deerhounds on the other; and it is also presumed that the sheepdogs and hounds trace their origin directly to the same ancestral form. On the other hand terriers and Pomeranians are believed to have sprung from a totally different extinct stock. Dr. Studer may be perfectly right in these respects, but he has yet to prove that *Canis pontiatini* is a truly wild form, and not a domesticated derivative from the wolf.

A Mysterious Reptile.

In the *Transactions* of the New Zealand Institute a dignitary of the Church records some interesting information with regard to an unknown reptile supposed to inhabit the Waoku Plateau. Legends are rife as to the existence of this creature, which is said to be amphibious; and about five-and-thirty years ago an example, in a decomposing condition, is reported to have been seen by a European. A second specimen, about 18 inches long and of a yellow colour, is said to have been observed by a lake about fifty years ago. The suggestion has been made that the creature is a salamander; but, from the distribution of that group, this is highly improbable. If it be anything more than a myth, it is far more likely to be an amphibious representative of that strange reptile the New Zealand tuatera, the sole known survivor of an extinct order.

Tsetse Fly.

All that is known concerning the geographical distribution of those terrible African pests, the tsetse flies, will be found in a map accompanying the latest issue of the Royal Society's reports on the sleeping-sickness.

REVIEWS OF BOOKS.

The Microtomists' Vade-Mecum, by Arthur Bolles Lee. Sixth edition, pp. x. and 538. (J. & A. Churchill, 1905; price 15s. net).—This well-known book was first published in 1885, and the volume before us is the sixth edition, the previous edition being issued in 1900. This alone would show that the book is a useful one, but the fact is that to the worker with the microscope, whether in anatomy, or physiology, or zoology, the book has become indispensable as a work of reference. It is above all things a book for the serious worker, but the amateur, if he has the root of the matter in him, and wishes to understand the methods of preparation of objects upon which modern microscopical research is now so largely built, will find it most instructive. To the professional worker, however, it no longer needs recommendation. It represents exceptional labour in bringing together so many methods and formulæ, and not less judgment in deciding what to omit where the mass of material for selection is so great. The new edition varies from the previous one mainly in the direction of consolidation and perfecting of the arrangement of the subject matter. The old chapter on "Staining with Coal-tar Colours" is now embodied in the chapter on "Staining" generally. The chapter on "Connective Tissues" and on "Blood and Glands" appears now as two separate chapters, and they contain much new matter, having been, in fact, largely re-written. The chapters dealing with the nervous system have been re-arranged, and have received especial attention, with especial reference to new methods. The bulk of the matter deals, of course, with histological methods for man and the higher vertebrates, and one might perhaps wish that the methods for the invertebrata could be slightly extended.—F.S.S.

Methods in Microscopical Research-Vegetable Histology, by Abraham Flatters, F.R.M.S.; pp. x. and 116; 29 illustrations in the text and 22 coloured plates containing 85 figures (Sherratt and Hughes, 1905; price 21s. net).—Unlike the book reviewed above, this work is written for the elementary student, and not for the advanced worker. In fact, the title is somewhat misleading—unintentionally, no doubt—as the elementary methods in vegetable histology dealt with here can scarcely be considered as methods of research, as the term is generally understood, however suitable they may be for teaching a class of beginners their first steps in botanical histological methods. Mr. Flatters selects some half-dozen well-known fixing and preservative reagents, and a dozen or so simple stains, and explains the various processes by which a botanical specimen can be prepared for section-cutting, either by the celloidin or paraffin-infiltration methods, cut in the hand-microtome, stained and mounted. The instructions generally are based on those carried out by Mr. Flatters' class in the Manchester Municipal School of Technology, and are clear, concise, and adequate for their purpose. The accompanying letter-press is beautifully illustrated, but some of the illustrations seem to be rather superfluous—for example, an illustration of eleven ordinary hollow-ground slides of different sizes and shapes, or of twelve "rings" of different sizes for building up deep cells. The plates are devoted to illustrations of various botanical sections prepared by the above methods, with brief descriptions. They are beautifully reproduced in colours, and appear to be for the most part from photo-micrographs, and, if not differing greatly from the ordinary botanical slides sold by the better-class opticians, at least serve to show what similar slides should look like, and have a considerable educational value as well. The best of these reproductions of slides is one showing mitotic division in a longitudinal section of an onion. We are not quite sure whether the volume under review is published in the ordinary way, or is an advance copy of a work to be published by subscription, conditional on a minimum of 200 subscribers being obtained.—F.S.S.

The Uses of British Plants. Books dealing with British plants are legion, but one treating the subject from a new point of view is decidedly a novelty. It may be argued that no new idea is presented; nevertheless the information brought together was previously scattered through publications, dating from the fourth century B.C. up to the present day. The reader is introduced to many peculiar views entertained by people of past ages as to the virtues of our common wild plants from a medicinal standpoint. The etymology of both English and Latin names is instructive. Finally, the numerous figures, illustrating 288 British plants, adds to the value of the book.

Everyday Life Among the Head-hunters; and other Experiences from East to West. By Dorothy Cator, pp. xiv. and 212; illustrated (London, 1905: Longmans, Green and Co.; price, 5s. net).—Apart from "experiences" on the West Coast of Africa and elsewhere, which, although entertaining enough in their way, are of no very special interest, Mrs. Cator has given an account of some of the little-known tribes in the interior of the great Malay island which accords to her brightly written little volume a value far above what can be claimed for many works of a similar nature. And not only is the author to be congratulated on having furnished so much information with regard to these native tribes, but she is entitled to a high position among Englishwomen who have done credit to their race and country by their personal prowess and pluck. As the companion of her husband on several journeys connected with his official position into the interior of Borneo, Mrs. Cator had the opportunity of seeing tribes to whom a European was previously unknown, and from whom it was a question as to the kind of reception which would be accorded to the travellers. Fortunately, all turned out well, and the author is enabled to bear testimony to the civility with which even the most truculent of head-hunters receive strangers, and to their quiet and affectionate family life when they are not on the war-path. Gifted with an observant mind, and with the power of recording her impressions in pleasant and readable language, the author has, we think, scored a decided success in this book of travels among the head-hunters of Borneo.

Magnetic Induction in Iron and other Metals, by Professor J. A. Ewing (Electrician Publishing Office). We have received a copy of the third edition of this classical treatise. It is a veritable *vade mecum* for the electrical engineer, or, indeed, also for the theoretical physicist. Commencing with the simplest definitions of magnetic qualities, the author extends the treatment so as to include not only directly magnetic phenomena, but also a large number of secondary effects which arise from the effects of stress. The general method followed is that of the magnetic circuit, as introduced by J. and E. Hopkinson, a method which is analogous to the electric circuit method for dealing with electric currents. By means of this method great simplification arises in the solution of problems in connection with dynamos and transformers. The chapter which will probably be found the most interesting to readers of this journal is that on "Molecular Theory," in which it is shown in detail how all the properties of a piece of iron can be imitated by a group of small pivoted magnets. When these are arranged at random the assemblage behaves like non-magnetised iron. When placed in a magnetic field a certain amount of alignment takes place amongst the small magnets; the assemblage has then all the properties of a magnet, and this is the more so as the alignment becomes more complete. The concluding chapter on "Practical Magnetic Testing" is new to this edition.

An Introduction to the Study of Colour Phenomena, by J. W. Lovibond (E. and F. N. Spon, Limited, London).—The main object of the work described in these pages was the construction of a series of glass standard colour scales, which are correlated to some physical colour constants, and by means of which a colour sensation can be measured, recorded, and reproduced at will. The author adopts coloured glasses for this purpose, and has had constructed a series of grades of glass of different tints, by comparison with which—taken singly or in combination—any colour can be classified. To physicists who are accustomed to refer all tints to a standard spectrum, specifying each by the wave-length of the light referred to, such an elaborate system of coloured glasses seems not only unnecessary, but somewhat arbitrary. The writer of this notice has seen a box of these glasses, and the standard yellow glass appeared to him to be a distinct citron-green. This in itself is, of course, no serious objection, assuming that the same standard tint can be reproducible at will. To ensure this a comparison is made with a definite thickness of the solution of some pure salt, such as copper sulphate. Although the arbitrariness of the scale of tints makes them useless for scientific purposes, it is possible that they may be of use in the identification of certain manufacturing products. We do not think, however, that their limited utility will repay the enormous labour which has evidently been spent in producing them. This small volume is beautifully illustrated by hand-coloured diagrams.

Researches on the Affinities of the Elements, by Geoffrey Martin, B.Sc., pp. xii. and 287 (London; Churchill; price, 16s. net). Since the days when Newlands pointed out that the elements arranged in the order of their atomic weights exhibited progressive relationships recurring at certain periods in the series, this "periodic law," as it subsequently became in the hands of Mendeljeef, has formed the basis of much of the speculation in chemical philosophy, and has borne fruit in the discovery of new elements predicted theoretically as necessary to fill gaps in the series. Mr. Martin's book also deals with certain aspects of the periodic system, and is a valuable contribution to the philosophy of chemistry. It is well known that the various elements differ in their degree of attraction for other elements, but hitherto no systematic attempt has been made to discover whether these affinities varied in accordance with any rule. Numerical data are very scanty, and consist of measurements of the heat of combination of the different elements with one another, and hence the author's conclusions have had to be based largely on qualitative differences in the readiness with which parallel compounds can be decomposed into their constituents. But after making allowance for the roughness of the method, it is shown that when the elements are arranged in their periodic order, their "affinity surfaces," when compared, assume "the positions of an advancing wave" repeating itself at the successive cycles in the system. Full directions for obtaining these geometrical representations or "affinity surfaces" are given, together with a large folding plate showing those of 14 of the more important elements. This "wave law" is illustrated by an immense amount of experimental results collected from scientific publications and arranged in tabular form. Several other conclusions are drawn from a consideration of the facts, and all are supported by very able reasoning. Unfortunately the style frequently leaves much to be desired, and the book teems with irritating misprints, in addition to the long list of errata given at the end.

Elementary Chemistry: Progressive Exercises in Experiment and Theory, by F. R. L. Wilson, M.A., and G. W. Hedley, M.A., pp. xii. and 167 (Oxford: Clarendon Press; price 3s.).—The authors state in their preface that this book is intended to train the thinking powers of the pupil rather than to fill him with chemical facts, and the series of progressive exercises and questions they have devised appears admirably adapted to carry out this aim. They begin with simple measurements involving the use of the metric system, and then deal with the construction of simple apparatus, the thermometer, the chemical balance, solution and crystallisation, the properties of liquids, and finally the identification of substances by their physical properties. In short, it would be difficult to find a more thorough or complete introduction to physical chemistry. The book is well printed on good paper, and gives clear illustrations of the apparatus described in the text.

An Intermediate Course of Mechanics, by Alfred W. Porter, B.Sc. (Murray; price 5s.). As may be gathered from the title, this book is intended for students at College Lectures, and aims at giving them a clear idea of general principles rather than fulness of details. The subjects of rectilinear translation, momentum, vectors, &c., are clearly explained, and the mathematics introduced are not too deep, as is so often the case in such text books. A chapter on the Mechanics of Fluids is added, and appendices give many examples and specimen examination papers.

The Origin and Influence of the Thoroughbred Horse (Cambridge Biological Series, 1905; pp. xvi. and 538, illustrated; price, 12s. 6d. net). Although an archæologist in place of a naturalist by profession, the author of this well-illustrated volume is to be congratulated on having brought together a vast store of valuable information—much of which was difficult of access to the ordinary naturalist—with regard to the vexed question of the origin and distribution of our domesticated breeds of horses, and more especially the English thoroughbred and its ancestral type—the Barbs, Turks, and Arabs. It is true, indeed, that he is somewhat vague as to what constitutes a species and a sub-species, or race, and that there are numerous inconsistencies and errors in his summary of the existing forms of the *Equidæ*; but, as a matter of fact, this part of the subject has comparatively little bearing on the main thesis of his work, and, in our opinion, it would have been no loss had the greater part of this been altogether omitted.

The author's main contentions appear to be as follows. Adopting the views of previous works as to the distinctness of the thoroughbred stock from that of the horses of northern Europe and northern and central Asia, Professor Ridgeway believes in the existence of three distinct types of horse. Firstly, the Celtic type, from Iceland, the Hebrides, and other parts of north-western Europe. Secondly, the tarpan, now represented by some forms of the so-called *Equus przewalskii*, of Mongolia. And, thirdly, the North African, or Barb type, inclusive of Arabs, Turks, and the modern thoroughbred. The first two are represented by small breeds of large-headed horses, showing a marked tendency to dun-colour, with dark brown legs. From their small size, they were first broken for driving instead of riding, and, owing to their intractable disposition, were controlled by means of the bit. The Barb type, on the other hand, is represented by horses of larger size, with relatively smaller heads, and of more slender build, whose typical colour appears to be bay, frequently accompanied by white "stockings" and a white star on the forehead. Their more tractable disposition led to these horses being controlled by a nose-band in place of a bit, while from their superior size they were in the first instance broken for riding. Northern Africa is held to have been the original home of this stock, which was not introduced into Arabia till a comparatively recent date. Barbs, Turks, and finally

Arabs formed the original basis of the thoroughbred strain; but Barb stock, in the author's opinion, is also to be detected in the English Shire horse, as indeed in most of the dark-coloured breeds. With the general scope of these conclusions, most naturalists will, we think, be disposed to agree; but in regard to the place of origin of the Barb-Arabian stock, and the now extinct wild form from which it is derived (on which latter point the author is in the main discreetly silent), there may be two opinions, and the question will have to be solved by palæontological evidence. As to the value of Prof. Ridgeway's work—to those capable of reading between the lines—there can be no question.

Religion for all Mankind, by the Rev. Charles Voysey (Longmans, Green, and Co.; 1s. net). Religion, in its wide sense, is a subject usually of the most polemical nature. The believers of one persuasion are never in agreement with the expositors of another system. Statements in the Bible and in other code books are frequently called in question by those not imbued with the sentiment that binds them to that particular creed. Yet here is propounded a religion "based on facts which are never in dispute." The tenets of the Theistic Faith have long been known, but Mr. Voysey, wisely enough from his point of view, desires to instil into the minds of his fellow-men more evidence of the reasonableness of the principles which he propounds. He keeps himself absolutely clear of all so-called "Divine Revelation" as authority, and by so doing can give offence to none. Many of the true and beautiful words of the Bible are quoted, but only as illustrations, not as a basis of belief. Compared with the dogmatic assertions of some religious writers, who, in their narrow minds, presuppose that their readers must believe every word they are told, the simple statements here given are a pleasure to read. "It is the right and duty of every man to think for himself in matters of religion," is the first article of Theistic Faith, and whatever form of religion we may happen to adhere to, we must agree that such a sentiment is perfectly correct, and this is typical of the book. We find throughout but little that can be objected to. There may be many who will not wax enthusiastic over these teachings; but, we think, all will agree that the author's words are fair and straightforward, and that to carefully peruse such a book tends to make us better men.

How to Know the Starry Heavens, by Edward Irving (Fisher Unwin; price 8s. 6d. net).—This is decidedly a good book. Its title and style are unassuming. One might have expected it to be a mere guide to the constellations, and, being by an American, one would not have been surprised had it referred to other matters entirely, but it is very much more than that. To call a small book of 300 pages a *complete* work on Astronomy would of course be a little too much, but in these pages there is very little of importance, to the man-in-the-street, that is left out. The wording is simple and explanatory, and due expression is given to the wonders described. Some pages digress, perhaps, too much into the fanciful. We are taken a trip into space "in the chariot of imagination," and, when half-way to the nearest star, we are told that "the scene is grand beyond the power of language to describe." Why it should be any grander than the view from our humble little earth on a clear night we do not know. We are then taken to visit "one of the stars." But a description follows which applies right enough to our Sun, as far as we know it. But do we know that any other star has "a glowing surface or photosphere, which has the appearance of being dotted over with still brighter specks like rice-grains"? And so on. Even the planets circling around it are in turn described. Why not call the Sun the Sun? Useful comparisons and similes are given to impress upon our mind the relative distances of heavenly bodies. It is thoroughly characteristic of the author's nationality not merely to point out that it would take 5000 years to travel by express train to Neptune, but also to add that "the railway fare, at one cent a mile, would be nearly $28,000,000—this makes a railroad impracticable!" The book is most admirably illustrated, not only by reproductions of some of the beautiful photographs now available, but also by several coloured plates.

Results of Rain, River, and Evaporation Observations made in New South Wales during 1901-2.—For many years past an annual volume containing the results of the rain, river, and evaporation observations made in New South Wales has been published, but owing to the economies recently enforced by the State Government, the volumes were suspended for some time. The results for the two years 1901 and 1902 have now been issued in one volume. Mr. H. C. Russell, F.R.S., the Government Astronomer, has been successful in getting together an army of over seventeen hundred voluntary rainfall observers. The annual volumes have become extremely valuable as so many interests are dependent upon the rainfall in the Colony. The two years 1901 and 1902 were marked by severe drought. In the year 1902 the average rainfall for the whole State was only 14·09 inches, which was the lowest average on record, with the exception of 1888, when the rainfall was 13·40 inches. The year 1888 was, however, followed by a series of years having plentiful rainfall, while 1902 on the contrary was the eighth consecutive year of drought. The drought was most intense in the western country, where dust and sand storms prevailed, caused by persistent dry winds. Sand storms proved a most destructive agent in the back country; drift sands and light dead weeds were carried over the plains until stopped by fences, where the banked-up sand formed dunes. The effect of the drought was most severely felt in the sheep-rearing industry. Mr. Russell says: "During the seven years ending 1901 the number of sheep grazing in the Western Division had dwindled from 16,000,000 to about 5,000,000. Taking into consideration the value of the sheep as a wool-producer, and the possible natural increase had there been no drought, this represents a loss to the State of at least £30,000,000. In the case of Momba Station, which is one of the largest in the State, the biggest shearing in one year was 420,000 sheep; in the year 1902 this number became reduced to 70,000." The effect of the drought is shown in a peculiar manner by the decrease in number of voluntary observers; in previous years these had shown a steady annual increase, from 96 in the year 1878 to 1719 in the year 1901, but this number fell to 1650 in the year 1902, which was brought about in a large measure by owners being compelled to temporarily abandon their homesteads.

Results of Meteorological Observations in New South Wales during 1900, 1901, and 1902.—This volume contains the daily observations made at the Sydney Observatory, and the monthly results from about fifty stations in various parts of the Colony.

Successful Negative Making, by T. Thorne Baker, F.C.S., F.R.P.S. (*Focus* office, Harp Alley; price 6d.), is a simple little book of 40 pages, which puts clearly and concisely, yet quite fully, all about dry plates, in theory and practice, exposures, and developments. It is quite a good practical guide, but would certainly have been the better for a list of contents and an index.

Pattern Making, by Joseph E. Dangerfield (Dawbarn and Ward; 6d. net), is one of those useful and thoroughly practical little guides included in "The Home Worker's Series," which will be found of great assistance to those entering upon such work.

Problems of the Future, by Samuel Laing, is now issued in a sixpenny reprint published by Messrs. Watts and Co. The book is already very well known, and we can only advise those who have not read it to make a point of acquiring it and spending a few odd half-hours among the realms of the fascinating mysteries of science. The book has been revised and brought up to date by Joseph McCabe.

Thermometers and Pyrometers.—Messrs. John J. Griffin and Sons have issued a catalogue of their instruments for measuring temperatures from $-200°$ C. to $4000°$ C., which include almost every variety of mercury thermometer and electrical-resistance pyrometers.

Science Data and Diary is an excellent little pocket-book, issued by Messrs. Philip Harris and Co., of Birmingham, and is replete with useful information on physical and chemical matters, together with a diary, cash account, &c.

We have received from Messrs. Hirschfeld Bros. a set of their *Star Calendar* for 1906, price 1s. net. This consists of 4 cards, suitable for hanging up, on which a rough but clearly marked map of the constellations "as seen in the northern hemisphere in January, February, and March," (or other three months) is given. There is also a calendar for each month, and a list of planets with the constellations in which they are to be found during the month.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 280.)

Under any circumstances the lamp or other source of illumination must be provided with some means of adjusting it both vertically and laterally. This is nearly always provided with the oxy-hydrogen jet, and the ordinary microscope lamps are generally supplied with an upright rod upon which they move vertically. The horizontal adjustments are easily obtained by arranging a wooden stand to run lengthwise in the parallel guides of the baseboard, and another stand above this running in parallel guides, whose motion is across and at right angles to the lower stand. The two can be clamped together with a thumb-screw. Such an arrangement could easily be made at home.

It will be found a great convenience if a similar stand be made for the microscope, but the more general method is to arrange a clamp of some sort and shoulders against which the foot may come so that once the microscope has been definitely adjusted in its proper position and the shoulders fitted accordingly it may be an easy matter to replace the microscope at any time and to clamp it securely, with the certainty that it is correctly placed. The Continental stand with its horse-shoe base is so unsteady when in the horizontal position that it absolutely needs some such clamping arrangement, but the English tripod is nearly as steady in this position as when upright, and in the case of one of my own microscopes I have merely to drop the three feet of the stand into three little metal rings screwed on to the baseboard and which were carefully placed correctly once for all.

The loss of light in photo-micrography is so considerable that some means of strengthening the illumination is necessary, and this is done by means of an auxiliary condenser placed between the light and the sub-stage condenser of the microscope. A further necessity for such an auxiliary condenser is due to the importance in photo-micrography of equally illuminating the whole field of view. With ordinary visual microscopic work this is not necessary, and the advanced microscopist rigidly focuses his lamp flame with a view to getting the best image in the particular portion of the field under examination, and cheerfully neglects the comparatively ill-illuminated portions of the field on each side. But this is manifestly not admissible in a photo-micrograph, and any alteration in the focus of the sub-stage condenser to do away with this light streak would not only depreciate the image, but cause a considerable loss of light. So the auxiliary condenser is interposed. There are three ways in which this condenser can be adjusted, and this is a point that is generally insufficiently dealt with in books on the subject of photo-micrography. To begin with, the auxiliary condenser can be adjusted to give parallel light or converged light. Of these, the second is the one usually used, the bull's-eye being so adjusted as to bring the light to a focus 10 inches or so away from the sub-stage condenser, which is then focussed on this point. A little experimenting with the bull's-eye in various positions will be found very instructive and helpful. The plane side of the bull's-eye should be turned towards the light and brought comparatively close to it, as in this position the aberrations of the ordinary uncorrected nearly hemispherical bull's-eye are least in evidence.

(*To be continued.*)

Royal Microscopical Society.

At a meeting held on October 18 at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., President, in the chair, an old Wilson screw-barrel simple microscope, date about 1750, presented by Major Meade J. C. Dennis, was described by the Secretary, who traced the history of microscopes, focussing by means of a screw cut on the body-tube, from Campani in 1686, Grindl in 1697, Bonnani in 1691, Hartsocker in 1694, to Wilson in 1702, who was followed by Culpepper some time prior to 1738, and Adams in 1746. Mr. E. Moffat exhibited and described a simple portable camera for use with the microscope. It consisted of a vertical telescopic standard drawing out to 28 inches, with a clamp at its lower end to secure it to the edge of the table. At the upper end of the standard was fixed a mahogany board, $\frac{1}{4}$ inch thick × 4 ins. × 5 ins., hinged at the pillar so as to close up, and having a hole in the centre about 3 ins. in diameter. There were two spring clips for securing the dry-plate while making the exposure, and guides for keeping it in position horizontally. The back of the dry-plate was covered by a piece of cardboard painted dead black, the spring clip referred to pressing upon this card. Depending from the board was a tapered bag of black Italian cloth about 17 ins. long with a rubber ring at the lower end to secure the covering to the eye-piece of the microscope. The apparatus can be closed up into a space 5 ins. × 9 ins. × $1\frac{1}{2}$ ins., and will thus go into a large pocket or a knapsack. If made of aluminium the weight should not exceed $1\frac{1}{2}$ lbs. The designer stated that this camera would work well up to 700 diameters, and could be made in brass for 21s., though aluminium would cost more. The Secretary exhibited and described a hand microtome designed and used by Mr. Flatters. It was made of brass and had a tube 3 ins. long and 1 in. inside diameter. The spindle had a screw of 28 threads to the inch, and was actuated at the lower end by three interchangeable notched discs, engaging with a spring stop, the tension of which could be adjusted. Sections could thus be cut varying from $\frac{1}{2000}$ to $\frac{1}{1200}$ inch in thickness for each notch that the disc was turned. The knife-plate was made of hardened brass. The aperture on the upper side was of somewhat smaller diameter than the rest of the tube to prevent the specimen turning. Messrs. R. and J. Beck exhibited the Aske Finlayson "Comparascope" (described in "Knowledge" for November last, page 281). A paper was read by Prof. Henry G. Hanks, a corresponding Fellow of the Society, entitled "Notes on Aragotite, a Rare Californian Mineral," first described by Mr. F. E. Durand in a paper read before the Californian Academy of Sciences on April 1, 1872. The President called attention to an exhibition of a number of slides from the collection recently presented to the Society by Mr. W. M. Bale, of Melbourne, including some excellently mounted orchid seeds.

Quekett Microscopical Club.

At the 424th ordinary meeting of the Quekett Microscopical Club, which was held at 20, Hanover Square,

W., on October 20, the President, Dr. E. J. Spitta, F.R.A.S., in the chair, Mr. James Burton read a paper, "On an Easy Method of Staining and Mounting Micro-Algæ and Fungi." The method described may be briefly summarised as follows:—Fix the fungus by one or more drops of 90 per cent. alcohol; follow with 25 per cent. alcohol; wash out with distilled water; add a drop of glycerine stained with Hoffman's blue, and cover. The fungus absorbs the stain from the glycerine, which acts also as a preservative medium.

Mr. F. P. Smith continued his revision of the classification of the spiders of the sub-family Erigoninæ, dealing with those species which he included in the *Walckenaëria* group. A complete bibliography of the group will appear in due course in the Club's journal.

Mr. Smith also described a new British spider from Great Yarmouth, under the name *Anglia hancockii*. It is one of the largest known forms of its sub-family, the Erigoninæ, and appears to be of a very early type.

There was a crowded meeting of members, who listened with regret to the announcement of the death of their veteran Vice-President, Mr. J. G. Waller, who had died on the previous day at the great age of 92. Mr. Waller, who was also well known as an artist and archæologist, joined the Quekett Club in 1868, and had served for a great number of years on the Committee. He was elected President of the Club in 1896 and again in 1897, and served as a Vice-President from 1898 until his death.

Notes and Queries.

Capt. H. D. Foulkes, Fort Purbrook.—Your question raises an interesting and practical point. The resolving power, that is, the ability to separate a maximum number of lines to the inch, is directly dependent upon the numerical aperture of the objective. Therefore a $\frac{1}{6}$ inch of N.A. 1·5 will theoretically have the same powers of resolution as a $\frac{1}{10}$ inch of the same aperture. But to resolve a number of lines and to make them evident to the eye are two different things. The average normal eye is generally stated to be able to distinguish 200 lines to the inch at the normal visual distance of 10 inches. Therefore the image given by either objective must be magnified sufficiently by the eye-piece to make such lines distinguishable by the eye. Now, in theory apochromatic objectives will bear any amount of eye-piecing, but this is not so in practice, even apart from the loss of light, and the higher powers bear high eye-piecing less satisfactorily than the low powers. These limitations are still more evident with achromatic objectives. So that if the maximum resolution be imperatively required a $\frac{1}{6}$ inch of N.A. 1·5 would in practice be less satisfactory than a higher power of the same aperture because of the high eye-piecing required to make the lines visible. But if such maximum resolution be not requisite, in other words if the object does not need such extreme resolution, then there are several advantages attendant upon the use of the lower-powered objective of the same aperture. Firstly, the working distance is greater; secondly, the field of view is larger; thirdly, the loss of light of the two objectives is proportional to the square of the magnification; and fourthly, though the amount of light dependent on the aperture varies as the square of the N.A. (which of course in any pair of objectives increases in a much smaller ratio than the magnification) in the two objectives under discussion the N.A. is identical. Therefore, if the work is of such a nature that moderate magnification only is required the lower-powered objective is preferable. With a pair of still higher powers of equal aperture the lower power would be preferable under almost all circumstances. Let us take for instance a $\frac{1}{12}$ inch achromatic of N.A. 1·25 and a $\frac{1}{14}$ inch of the same aperture, or an apochromatic $\frac{1}{8}$ inch of N.A. 1·4 and a $\frac{1}{12}$ inch of the same aperture. In the first case a quite moderate eye-piece, which the objective can well stand, will show all that a $\frac{1}{12}$ of N.A. 1·25 can resolve and the drawbacks incidental to using a $\frac{1}{14}$ inch of higher magnification, but of the same aperture will bring with them no compensating advantage. With the pair of apochromatics of N.A. 1·4 the $\frac{1}{8}$ inch will require rather higher eye-piecing to make the maximum amount of structure evident, but still it will not be more than an apochromatic can well stand, and so it again is preferable to the $\frac{1}{12}$th.

J. T. Orme, York.—For the chemical tests for mechanical wood pulp and esparto grass (as aids to microscopic examination only) I must refer you to my series of articles in "KNOWLEDGE" on the "Fibrous Constituents of Paper" in the issues of February, March, April, and May of this year, pages 42, 68, 92, and 114. There are no chemical tests in bulk, unless the somewhat untrustworthy use of aniline sulphate as a test for mechanical wood pulp may be looked upon as such. Cross and Bevan's book is the best text-book on papermaking, and deals with such chemical analyses as are practicable for paper. Griffin and Little's book is more a manual of chemistry specially written for papermakers. A very good little book in certain respects is Hertzberg's "Paper Testing," translated by Dr. Norman Evans, and published in 1892 by W. J. Stonhill, at the offices of the *Paper Trade Review*. This is the nearest of the German books to what you require. I am afraid I cannot give you any information on the subject of "smalt," other than you appear to have already, and I am sorry that the many claims upon my time will not permit of my making an analysis for you of the sample you send.

Major E. F. Becher, Cheltenham.—You do not give me the focal length of your bullseye, so it is not quite easy to answer your question definitely. The most obvious suggestion is that the 2-inch objective takes in a larger field than the sub-stage condenser could illuminate, until in altering both condensers you adjusted the latter so that the rays crossed and thus illuminated the whole field. If you were using one of the ordinary Abbe sub-stage condensers and not one of the new macro-illuminators, this is probably the correct explanation. Of course, if your light were correctly focussed upon the object you would get a disc of light smaller than the objective with the 1 inch also, but the spherical aberrations of the bullseye you had interposed between the light and the sub-stage condenser would prevent such accurate focussing, and you would thus get a disc of light large enough to illuminate the whole field taken in by the latter objective. With regard to investigations into the nervous system of insects, a certain amount can be done by careful dissecting, especially in gaining a true impression as to the relations of various parts. This will, of course, need to be done under a dissecting microscope and probably under water, the insect being pinned down to wax run into the bottom of the dissecting dish or to a piece of cork weighted with lead and placed in the dish. I do not think it will be practicable to attempt to stain the nerves and their ganglia *in situ* by any differential stain which will stain the nerves only, whilst the other parts and the chitinous exo-skeleton are left transparent. Your method will therefore be to proceed by means of serial sections, both transverse and longitudinal, and this will need careful preparation of the object beforehand, and a certain amount of experiment before you decide on the best fixing and other reagents and stains. For fairly thick sections the celloidin method will do, and the sections can then be cut with any good microtome. But for really first-rate sections the object must be prepared for infiltration with paraffin (not embedding merely), and be cut on a good rocking microtome such as the well-known instrument made by the Cambridge Scientific Instrument Company. Have you had any experience of infiltration methods? If so, your task will be greatly lightened. You will probably have to stain the sections *upon the slide* by some differential nerve stain. Eau de Javelle would probably be a good method of making the chitin transparent, as it is stated to have no effect upon such delicate structures as nerve endings and to render the chitin permeable to staining fluids, but my experience has been that it requires to be used with great care. The solution should be diluted to 4 or 6 times its volume of water, and the object left in this for 24 hours, or much more, according to size. You might use this reagent before dissecting. If you then wish to go on to make serial sections, I will try to explain how to set about it.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for December.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.46 and sets at 3.52; on the 31st he rises at 8.8 and sets at 3.58.

The equation of time is negligible on the 25th.

Winter commences on the 22nd, when the Sun enters the sign of Capricorn at noon. Solar activity is well marked, many spots of late being visible to the naked eye, whilst prominences have been particularly brilliant.

The following table gives the position, angle of the Sun's axis, and the heliographic latitude and longitude of the centre of the Sun's disc:—

Date.	Axis inclined from N. point.	Centre of disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ..	15° 48′ E	0° 33′ N.	310° 44′
,, 12 ..	11° 35′ E	0° 44′ S.	178° 58′
,, 22 ..	6° 58′ E	2° 0′ S.	47° 14′
Jan. 1 ..	2° 8′ E	3° 11′ S.	275° 30′

THE MOON:—

Date.	Phases.	H. M.
Dec. 3 ..	☽ First Quarter	6 38 p.m.
,, 11 ..	○ Full Moon	11 26 p.m.
,, 19 ..	☾ Last Quarter	0 9 p.m.
,, 26 ..	● New Moon	4 4 a.m.
,, 7 ..	Apogee 252,100 miles	10 6 p.m.
,, 23 ..	Perigee 225,800 ,,	10 12 p.m.

OCCULTATIONS:—

Date.	Star's Name.	Mag.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p.m.		p.m.		d. h.
Dec. 8	μ Ceti	4·4	5.35	52	6.43	263°	12 1
,, 9	f Tauri..	4·3	4.49	101°	5.43	220°	13 0
,, 10	γ Tauri..	3·9	4.58	84	5.56	244	14 0
,, 10	75 Tauri..	5·3	10.3	60	11.22	269°	14 5
,, 10	B.A.C 1391.. ..	4·9	11.37	137	12.18	197	14 7
			a.m.		a.m.		
,, 11	Aldebaran ..	1·1	2.52	109	3.53	238	14 10

THE PLANETS.—Mercury (Dec. 1, R.A. 17^h 58^m; Dec. S. 25° 26′. Dec. 31, R.A. 17^h 4^m; Dec. S. 20° 23′). Throughout the month the planet is not suitably placed for observation, being in inferior conjunction with the Sun on the 15th.

Venus (Dec. 1, R.A. 15^h 14^m; Dec. S. 16° 48′. Dec. 31, R.A. 17^h 53^m; Dec. S. 23° 23′) is a morning star in Scorpio, rising only a short time before the Sun, hence the planet is not well placed for observation.

Mars (Dec. 1, R.A. 20^h 52^m; Dec. S. 19° 6′. Dec. 31, R.A. 22^h 21^m; Dec. S. 11° 20′) is a feeble object in the evening sky situated in Capricorn and Aquarius, setting about three hours after the Sun.

Jupiter (Dec. 1, R.A. 3^h 54^m; Dec. N. 19° 17′; Dec. 31, R.A. 3^h 41^m; Dec. N. 18° 41′) is a brilliant object in the evening sky and is describing a retrograde path in Taurus. Towards the end of the month the planet will be situated about five degrees directly south of the Pleiades.

The planet is very favourably situated for observation before midnight, and forms with his belt like markings and bright moons a most interesting object even in very small telescopes.

The equatorial diameter of the planet on the 15th is 48″·5, whilst the polar diameter is 3″·1 smaller. The following table gives the satellite phenomena visible in this country, before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date	Satellite.	Phenomenon.	P.M.'s, H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Dec				Dec				Dec			
1	I.	Oc. D.	11 1	10	I.	Oc. D.	7 11	18	I.	Tr. E.	8 22
2	III.	Sh. E.	5 7		I.	Ec R.	9 47		II.	Sh. E.	8 55
	II.	Oc. D.	6 6	11	I.	Sh. I.	4 52		I.	Sh. E.	9 0
	I.	Tr. I.	8 16		II.	Tr. E.	5 20	19	I.	Ec. R.	6 12
	I.	Sh. I.	8 29		II.	Sh. E.	6 17	24	I	Oc. D.	10 43
	II.	Ec. R.	9 3		I.	Tr. E.	6 37	25	II.	Tr. I.	7 24
	I.	Tr. E.	10 27		I.	Sh. E.	7 5		I.	Tr. I.	7 56
	I.	Sh. E.	10 42	16	III.	Tr. I.	9 5		I.	Sh. I.	8 42
3	I.	Oc. D.	5 27		II.	Oc. D.	10 34		II.	Sh. I.	8 57
	I.	Ec. R.	7 52		III.	Tr. E.	10 41		II.	Tr. E.	9 58
4	I.	Tr. E.	4 53		III.	Sh. I.	11 16		I.	Tr. E.	10 8
	I.	Sh. E.	5 10		I.	Tr. I.	11 44		I.	Sh. E.	10 55
9	III.	Tr. I.	5 48	17	I.	Oc. D.	8 57		II.	Sh. E.	11 34
	III.	Sh. I.	7 15		I.	Ec. R.	11 43	26	I.	Oc. D.	5 9
	III.	Tr. E.	7 21	18	II.	Tr. I.	5 5		I.	Ec. R.	8 7
	II.	Oc. D.	8 19		I.	Tr. I.	6 10	27	III.	Ec. D.	5 15
	III.	Sh. E.	9 8		II.	Sh. I	6 19		I.	Sh. E.	5 23
	I.	Tr. I.	9 59		I.	Sh. I.	6 47		II.	Ec. R.	6 7
	I.	Sh. I.	10 23		II.	Tr. E.	7 38		III.	Ec. R.	6 57
	II.	Ec. R.	11 39								

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Dec. 1, R. A. 21^h 59^m; Dec. S. 13° 59′. Dec. 31, R. A. 22^h 8^m; Dec. S. 13° 11′) is due south about sunset and well placed for observation during the early part of the evening; near the middle of the month he sets about 9.20 p.m. The ring, which can be seen in small telescopes with moderate powers, appears well open as we are looking at an angle of 10°, on the northern surface.

Uranus is in conjunction with the Sun on the 26th, and hence is unobservable.

Neptune (Dec. 16, R. A. 6^h 41^m; Dec. N. 22° 9′) rises about 5 p.m. near the middle of the month, and is due south about 1 a.m. The planet is situated in Gemini, some 6° east of the star μ Geminorum, but in small telescopes without setting circles, it is difficult to identify from the numerous small stars in the same field of view, but he can be detected by his motion if observations are made on several successive nights. The planet is in opposition to the Sun on the 31st.

METEORS:—

The principal shower of meteors during the month is the Geminids, Dec. 10 to 12; the radiant is in R. A. VII^h 12^m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 3rd at 10.49 p.m., the 6th at 7.38 p.m., 26th at 9.21 p.m., and 29th at 6.10 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—1 Pegasi XXI^h 17.5^m, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ 0^h 31.5^m, N. 33°·11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1^h 56.9^m, N. 2°·17′, mags. 3·7, 4·7; separation, 3″·6.

ι Trianguli II^h 6.6^m, N. 29°·50′; mags. 5, 6·4; separation, 3″·5.

Clusters:—(ℌ VI. 33, 34). The Perseus clusters visible to naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M. 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° N.W. of Algol.

SUPPLEMENT.

*[Although it has not been usual to include fiction within the pages of "*Knowledge,*" the following discourse, which is but a tale built around a new and possibly important scientific proposition, seems to be one not inappropriate to the contents of a scientific journal.—*Ed.]

London's Transformation.

A Suggestive Sketch of Days to Come.

(*Continued from page* 286.)

By Tems Dyvirta.

[Cornelius Tush was a great American financier, whose modes of business were perhaps not always quite above suspicion. He had hit upon the great idea of diverting the course of the Thames so as to cause the river to flow away to the country, and leave its dry bed in London available for building sites.]

CHAPTER V.

Finesse.

For some days afterwards Mr. Tush was very busy interviewing many of the leading engineers, contractors, and land agents. To none did he reveal his great idea. He consulted this one about the cost of a big canal, laying down the conditions and circumstances, and leading his adviser to the belief that he was referring to some new Central American waterway. He talked to that one about the price of land in Kent and Surrey, as though about to buy a large estate. With others the expenses of bridges, of dams, of laying roads and other items were discussed. So, bit by bit, he compiled a full and complete estimate of his scheme.

The question was, would it pay? The new river should only occupy approximately the same area as the reclaimed ground, so that as regards the cost of purchasing land, it would only amount to an exchange of country for city property. Then again, much superfluous land would of necessity have to be bought bordering the deviation, but this would in all probability be greatly enhanced in value for building purposes, and might thus pay for the whole. There would then remain the value of, perhaps, 1,000 acres of reclaimed land as an asset; some of this might actually be sold before the water was removed from its surface; the *land* was there right enough. No one could deny that!

Tush decided to play the bear. In compliance with his invitation, numbers of influential men were calling to seek an interview with the great financier. Mr. Singman was one of the first to be ushered into his sanctum. "You require a large building plot centrally situated?" said Cornelius. "Well, I'm not a land agent, but I happen to know of the very article you require, but, can you pay the price?" Singman quoted some figures as to his requirements, and as to the capital he had at disposal to obtain the land. Tush regretted that the plot he knew of would cost considerably more, but then, he urged, it possessed such very suitable characteristics as to make it well worth the extra outlay. It had a large frontage on one of the principal streets of the city, was so situated as to be most easy of access by rail or 'bus, it had a wide pavement in front, and was surrounded by fine buildings. Singman, trying to picture the spot to himself, was somewhat puzzled, and finally broke in by requesting to be informed of the exact locality. "As I have said," retorted Tush, "I am no common land agent; this is an affair of some moment which requires secrecy. I am not at liberty to impart to anyone exactly what property this is, but you can take my word for it, it is all that I describe. It is a great chance for you, and I will give you the opportunity of thinking it over for one day. I will then require a decided answer as to whether you will take it or leave it." Singman thought it over, and, as he had also "kept a bit up his sleeve" by not naming so great a sum as could really be devoted to the object, he eventually decided to scrape together the required amount to purchase the unrivalled site. Very similar dealings were negotiated with other callers, till Tush felt that he had a very respectable sum practically in his hands.

Yet, as he considered carefully over the question, the vastness of the project and the many difficult problems involved filled his mind with doubts as to the feasibility of the scheme. The few sales of land which he had so far actually contracted for would, after all, bring in but a small fraction of the enormous capital necessary to complete the work. If but one of the land owners on the site of the deviation refused to sell, the whole plan might need alteration. The Bill which it would be necessary to bring before Parliament would certainly receive much opposition. The railway companies might object, as might the steamboat owners, and too large a compensation claimed.

On the other hand the whole matter had been very carefully gone into and it *ought* to pay handsomely. It was not likely to fail like the Panama Canal Company had done after spending sixty million pounds.

Could the Government do anything? Tush decided to lay the project before them; leave them to disentangle the multitudinous obstacle while he could make such stipulations as to guarantee for himself a goodly perquisite.

A few days later Tush was closeted with one of the principal heads of the department concerned. Arguments were adduced, such as a possible substantial addition to the revenue, an investment as good as the purchase of the Suez Canal shares, which increased six times their value in twenty years, and many other nice plums, calculated to attract a tottering ministry; but the Right Honourable Gentleman addressed could only

reply that the matter was hardly one which the Government could undertake, and that the public body most concerned, and, therefore, the proper quarter to appeal to, was the London County Council.

Interviewing the officials of the latter, and impressing upon them the great benefits to be derived from the scheme, the lowering of rates by the huge income from rents, and the great improvements to be introduced to the city, Tush was again doomed to disappointment by being informed that, on the whole, the scheme was considered to be of too speculative a nature for this body to undertake.

Nothing remained, therefore, except to endeavour to further the original idea of the formation of a huge company. An attractive prospectus would have to be concocted and issued broadcast, then, if the capital was forthcoming it would be necessary to get a Bill passed through Parliament to obtain rights for the compulsory sale of land to the company and the abolition of various vested rights.

A day or two afterwards Mr. Singman was again at the office craving an interview with the universal provider of moneys and lands. "I am getting a little uneasy," he confessed, "about our arrangements. You have pictured to me an ideal site for my establishment, yet though I have hunted London high and low I can find no such perfect place. Where does it exist? You might, at all events, name the district, if not the street, in which it is." The wily Tush was a little puzzled as to how to appease the curiosity of his client, not wishing to have to allow that the transaction was certainly problematical and uncertain, and not likely in any circumstances to be completed for some years to come. However, by stating that it was not far from the Houses of Parliament, that it was not south of the Thames, and that it faced one of the main thoroughfares, he succeeded in satisfying his over-inquisitive friend for a bit. Just as Singman was leaving the room, however, a thought struck him. "I thought you said it was in the *city?*" he suddenly interrogated. "No," replied Tush with the greatest calmness, "Westminster."

The next caller was FitzEdmund. "With respect to this plot of land, Mr. Tush, about which we have been negotiating, I happened to meet a day or two ago a gentleman who was dining with you that day, if you remember. Well, he mentioned that you were arranging to sell him a great plot of land, too. It isn't the *same* by any chance, is it?"

"Oh dear no; your theatre is to be in the vicinity of the Strand."

Having thus disposed of another awkward customer, Tush was feeling a little more relieved, when Lord Whittingbourne was announced. "My dear Mr. Tush, I don't at all understand what is going on. While sitting in your waiting-room just now, a gentleman came in, having just left you, and staring at me said, 'Oh, so I s'pose he's going to sell *you* a bit of City property, *too*, eh?' 'That is so, sir,' I replied, 'but I do not understand it all.'"

"Oh, there's nothing in that," said Tush, "that man couldn't scrape out the dollars to outbid you."

Then rumours spread around and were whispered here and there in the highways and by-ways. The great American financier had gone off his head! He had been selling plots of building land in the City freely to all who applied to him, and had already negotiated for the sale of such an amount as could not possibly be disposable in all the City of London!

Tush at last got to hear of these rumours. It would be absolutely necessary to make some explanation to appease the anxiety of those concerned, but how could it be done?

After long and careful consideration Tush came to the conclusion that there was but one solution to the difficulty. "Trust to truth." Accordingly each of the would-be purchasers had to be sent for over again, and each had to be carefully mollified and soothed, and to be persuaded that immediate possession was of no importance; and then the great scheme was gradually laid before them, and the certainty of its success impressed upon these "co-originators of the scheme, whose names would be indelibly connected with this grand and beneficial concern."

And soon the world at large were also taken into confidence. The glowing and persuasive prospectus convinced all men of the soundness and feasibility of the scheme, so that before many weeks had passed, a new and colossal company had sprung into existence, backed by the wealth of the nation.

CHAPTER VI.

PROGRESS.

Three solid years had slipped by since the banquet at the Savile; and what a change was manifest!

Cornelius Tush who, one way and another had by now recouped most of his lost fortune, stood once again on Westminster Bridge surveying the river and its surroundings. How different now the aspect to that which had met his eye three years before! That vast expanse of water had now dwindled considerably. Great wooden structures rose from the water. Caissons and hoardings hemmed in the river and limited its flow. Beyond, extensive banks of brown earth supported temporary lines of railway, along which crawled long trains full of earth dug from Surrey fields to fill in the bed of the river. A narrow strip of water was left along the southern bank forming a canal, crowded with barges.

Moving down from off the bridge, Cornelius approached a wooden shed among the lines bearing the sign "Temporary Offices," and soon after emerged with engineers, and foremen, and others, and was ensconced in an inspection car to go a trip round the works. The engine whistled and the little train rattled off along the shaky, roughly-laid line, passed St. Thomas' Hospital and the great Houses of Parliament opposite, and on it jogged towards Wandsworth. Vast were the works in progress. On all sides gangs of men at work digging, picking, shovelling, laying new lines, tearing up old ones, fixing up great cranes, making bridges and dams, demolishing old houses, erecting new sheds.

At Wandsworth was the junction where the deviation began. And here were in course of erection some large under-water turbines, which, by the flow of the river, were to convert its latent power into electrical energy, and to supply London with that most valuable commodity. Up the bed of the Wandle, that little stream which but a few years before had run so placidly and unostentatiously among the green meadows and pollard willows, was now a vast valley of excavations. Numerous steam diggers were puffing away at their gigantic tasks. Temporary bridges were being constructed for the railway lines and various roads passing over it. On went the inspection train towards Croydon. Here the work was stupendous. An enormous cutting, over 100 feet deep and of great width, was being excavated. Hundreds of acres of suburban land

were covered with this turmoil. Houses of all sorts, from the humblest cottages to the most magnificent villas, had fallen a prey to the Act of Parliament sanctioning the great work. Even whole villages had been swept away by the remorseless hand of the now celebrated Tush.

At various points the train stopped, while Tush got out to interview the officials or inspect some new piece of work, and then on he would go again. Now the distant form of the Crystal Palace, with its two towers so familiar to suburban *habitués*, came in view as the little train rattled along near the south end of its grounds. Even further was the great ditch continued through Beckenham and right on towards Greenwich, where new docks were to be constructed, with great locks to cut off the tide.

In some places, where land was not so precious, the spare earth was piled up into small mountains, instead of being carried all the way round to the City, and these would, in the future, form picturesque little hills overlooking the river.

One of the greatest difficulties proved to be the many railroads connecting the Metropolis with the south. Either there would be required a large number of long bridges, or they would need to be so altered and arranged that a number of them could utilise the same bridge, which was more economical in many ways. Some, on a low level, could tunnel beneath the New River.

Tush, satisfied with his tour of inspection, now took the ordinary train to convey him to the City, where he was to attend a meeting of the company, and troublous times were beginning to overshadow its peace and prosperity.

The "Thames Deviation Construction Company," with its capital of £50,000,000, was one of the biggest commercial concerns ever undertaken, and was not the chairman also one of the biggest financiers the world had seen? Yet discontent was rife among the shareholders. They wanted to know more. They asked this and they asked that, but they were always put off with vague replies. "Mr. Tush has arranged that," was considered a sufficient answer to allay all despondency and doubt as to certain possible difficulties. Then more sinister rumours began to get about; one of them, for instance, was to this effect :—

A certain gentleman in business in the City owned a small villa and a few acres of land near Carshalton. About three years ago a stranger, giving the name of Jones, called to see him and asked whether he was willing to sell the freehold of his little property. In due course the transaction was completed, and Mr. Jones became owner of the land on very favourable terms. Since then the land had been purchased by the Deviation Company for a very handsome sum; those knowing its true value being much surprised at the magnanimity of the great company. Well, all this might not have seemed a matter of any importance had not the worthy City merchant one day chanced to have pointed out to him the great Tush. "That Tush!" he said, "why I could swear that that is the man Jones, who bought my house at Carshalton." And then other stories of a very similar nature got about.

It transpired that about the time the company was first formed, Tush had become a very large shareholder in the "Conrad R. Pickie Steam Digger and Excavator Company," of Pittsburg, U.S.A., and that this firm, though not the lowest contractors, had supplied nearly all the machines used by the company for excavating. So, too, a certain architect, to whom much work had been entrusted, was found to be "subsidised" by Tush. Either under his own name, or that of his agent Bateson, he seemed to be interested in many different concerns connected with the great undertaking.

Thus it gradually began to leak out that the great capitalist was making money "hand over fist" in a number of different lines, quite apart from the main company. Indeed, it was suggested by some of the more pessimistic that he had already got rid of the greater part of his "Deviation" shares during the great boom of a year ago, and that he was now running the thing so as to suit his own interests rather than those of the shareholders.

Still all these awkward rumours were explained away by the co-directors and officials of the company, and things went on smoothly enough for some years. As the completion of the works began to become manifest, hopes rose in people's minds, and the shareholders cared not what Tush did, only so long as the great work should be satisfactorily completed.

CHAPTER VII.

The Opening.

At last all was ready. The huge cutting of the "New Thames" was complete; all except the dam which still held the waters, and bade them flow on in the path they had pursued for centuries. Once the dam was cut all would be changed, and the waters, rushing wildly over fields and pastures new, would dash onward to find their new course to the sea.

This, then, should be a most eventful occasion, and a fitting ceremony was arranged to take place. Large wooden stands were erected for the accommodation of the thousands of spectators. Royalty itself was to honour the proceedings with its august presence and support. All the big wigs in England had expressed their intention of attending. Cornelius had decided, in his usual personally ambitious manner, that this great occasion was not only to be the opening up of the new river, but that it would incidentally form the ceremony of exonerating him personally from all the wicked slanders that had been circulating more and more freely. He had made numerous plausible stories which *ought*, he thought, to explain away any harmful intentions on his part. But, unfortunately, as soon as one was disposed of, dark tales sprung into life about some other enormity that he was supposed to have committed. Now at last he hoped they were all satisfactorily explained, and that his pure and straightforward patriotism would be proclaimed to the whole world.

Then the day arrived! Wandsworth, the town which was now to be cut clean in two by a vast abyss, while a large portion of it had disappeared into that abyss, was *en fête*. The river beyond swarmed with boats of all kinds (for the rush of water was not to be so sudden as to cause any serious difference to the river that day). Flags flew from every suitable point. Strains of music and joyous voices rose from all around. The only sombre-looking spot was the vast brown excavation extending southward as far as the eye could see, on which all the interest hinged.

As the church bells slowly boomed forth the midday hour, bands struck up the National Anthem, and the roaring of thousands of throats rose in their loyal greetings to the occupants of a Royal carriage as it raced into the great enclosure surrounding the spot where the puny work was about to take place which

would represent the first cutting away of the enormous dam.

And there were two other figures which attracted the attention of the thousands of onlookers One was the man to whose master-mind this huge undertaking was due. Petty squabbles could, on an occasion like this, be forgotten or set aside, and the general public only recognised in that figure the founder of another prop, another addition to our Empire, of more importance perhaps than the settling of an extensive new Colony or the discovery of unknown territories, since the population of the reclaimed area was sure to become very shortly equal to that of a large Colony.

But what was the other figure? Equally fascinating to the public eye, and yet for a very different reason. The one with the sagacious, clear mind, sharp even to cunning, large minded even to unscrupulousness; the other innocence personified—a simple but extremely pretty little girl, Miss Libertia Tush. All eyes were drawn to gaze upon the charming childish figure, clad in white, with the huge bouquet, which she so gracefully deposited in Royal hands.

The sun broke forth in all his splendour, and cheers rent the air as the first trickle of water passed from the Thames into the new cutting. Everyone was enthusiastic and highly pleased. All except one, and that was the very person who should have been elated above all others at seeing the work of his brain brought into activity, and to realise that his ambitious dreams were actually accomplished! But his expectations in other lines had not been realised.

The highest in the land have to be guided by the feelings of the majority of their subjects. This great ceremony had very nearly to take place without that royal presence, the request for which had only been granted after special pleadings. The founder and chairman had expected honourable recognition of his great work before this; but nothing of the sort, no kind of encouragement had been held out to him, and he had only hoped that the announcement of his reward had been deferred to the final moment of the opening, then did he expect to be the recipient of such honour as would have for long thrown off the scurrilous and menacing attacks that had been made by envious persons as to his private financial transactions. But nothing had come of it! He had been received by Royalty with marked coldness, even though the eyes of the whole Court were attracted to Libertia, and had it not been for the ardent admiration shown for his little daughter, an awkward scene might have ensued. With the audacity acquired by one supreme in his own line, and with the anger of being foiled in his ambitions, he had actually enquired point blank whether he would be likely to receive such recognition from the hands of his august visitors as might be commensurate with the work which he had now brought so near completion. What was intimated in reply was nothing more nor less than a snub. He, Cornelius J. Tush, snubbed! It was more than he could stand. "Your bloated aristocrats could go to—where they like. What cared he for the beastly rags fluttering overhead? They could have the Royal ensign flying there, but the Stars and Stripes must come down. *He* wasn't one of that fat, phlegmatic, apoplectic John Bulls. No, thank goodness!" And so Tush turned on his heel, determined once and for ever to sever his whole connection with these schemes for the improvement of a "foreign town."

And so he did. His whole financial interest in the affair became transferred to other hands, and though his name, for various reasons, was still retained on the company's books, he, with his wife and child, returned to re-found their home in the States.

(To be continued.)